REPORT OF SURVEY CONDUCTED AT

DIRECTORATE FOR MISSILES AND SURFACE LAUNCHERS (PEO TSC-M/L)
ARLINGTON, VA

JULY 2002

Best Manufacturing Practices

1998 Award Winner

INNOVATIONS IN AMERICAN GOVERNMENT

BEST MANUFACTURING PRACTICES CENTER OF EXCELLENCE
College Park, Maryland
www.bmpcoe.org

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
01JUL2002	N/A	-

Title and Subtitle BMP Report of Survey Conducted at Directorate for Missiles and Surface Launchers (PEO TSC-M/L) Arlington, VA	**Contract Number**
	Grant Number
	Program Element Number
Author(s)	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Best Manufacturing Practices Center of Excellence College Park, Maryland	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es) ONR	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes The original document contains color images.	
Abstract	
Subject Terms	
Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 40	

Foreword

This report was produced by the Office of Naval Research's Best Manufacturing Practices (BMP) Program, a unique industry and government cooperative technology transfer effort that improves the competitiveness of America's industrial base both here and abroad. Our main goal at BMP is to increase the quality, reliability, and maintainability of goods produced by American firms. The primary objective toward this goal is simple: to identify best practices, document them, and then encourage industry and government to share information about them.

The BMP Program set out in 1985 to help businesses by identifying, researching, and promoting exceptional manufacturing practices, methods, and procedures in design, test, production, facilities, logistics, and management – all areas which are highlighted in the Department of Defense's 4245.7-M, *Transition from Development to Production* manual. By fostering the sharing of information across industry lines, BMP has become a resource in helping companies identify their weak areas and examine how other companies have improved similar situations. This sharing of ideas allows companies to learn from others' attempts and to avoid costly and time-consuming duplication.

BMP identifies and documents best practices by conducting in-depth, voluntary surveys such as this one at the Directorate for Missiles and Surface Launchers (PEO TSC-M/L), Arlington, Virginia, conducted during the week of July 8, 2002. Teams of BMP experts work hand-in-hand on-site with the company to examine existing practices, uncover best practices, and identify areas for even better practices.

The final survey report, which details the findings, is distributed electronically and in hard copy to thousands of representatives from industry, government, and academia throughout the U.S. and Canada – *so the knowledge can be shared*. BMP also distributes this information through several interactive services which include CD-ROMs and a World Wide Web Home Page located on the Internet at http://www.bmpcoe.org. The actual exchange of detailed data is between companies at their discretion.

The Directorate for Missiles and Surface Launchers is responsible for the "cradle-to-grave" management of the STANDARD Missile Program and oversees all variants of the Program inclusive of concept formulation, design, development, integration, acquisition, test and evaluation, Fleet introduction, modernization, and life-cycle maintenance. Among the best examples were the Directorate's accomplishments in Configuration Control Board; Government Program Office/Contractor Co-location; Technical Representative Office; Strategic Planning and Technology Management, and Simulation Accreditation Review Panel/Verification, Validation, and Accreditation Process.

The BMP Program is committed to strengthening the U.S. industrial base. Survey findings in reports such as this one on the Directorate for Missiles and Surface Launchers expand BMP's contribution toward its goal of a stronger, more competitive, globally-minded, and environmentally-conscious American industrial program.

I encourage your participation and use of this unique resource.

Anne Marie T. SuPrise

Anne Marie T. SuPrise, Ph.D.
Director, Best Manufacturing Practices

Contents

Directorate for Missiles and Surface Launchers (PEO TSC-M/L)

Contents (Continued)
Directorate for Missiles and Surface Launchers (PEO TSC-M/L)

Figures & Tables

Directorate for Missiles and Surface Launchers (PEO TSC-M/L)

Figures

Tables

Section 1

Report Summary

Background

The STANDARD Missile, launched from the proven Vertical Launching System, is among the most reliable and effective weapons systems in the Department of the Navy's tactical inventory, and offers primary air defense support for the AEGIS Ticondera-class cruisers; Arleigh Burke-class destroyers, and allied countries' navies throughout the world. The evolving STANDARD Missile family provides a robust anti-air warfare capability — a defense against high altitude, long-range, high crossing, and maneuvering threats. The Department of the Navy's Directorate for Missiles and Surface Launchers (PEO TSC-M/L), formerly the STANDARD Missile Program Office (PMS 422), is responsible for the "cradle-to-grave" management of the STANDARD Missile and Vertical Launcher Programs. PEO TSC-M/L oversees all variants of both programs inclusive of concept formulation, design, development, integration, acquisition, test and evaluation, fleet introduction, modernization, and life-cycle maintenance.

The STANDARD Missile legacy began in 1952 with the introduction of the TALOS missile, with initial firing at sea in February 1959 from the USS Galveston. TALOS was primarily a surface-to-air missile, but could be used effectively against ships and shore targets up to a range of 65 miles. The first generation TERRIER BW-0 ship-to-shore missile was introduced about the same time, and was based on beam and wing control technology. New design changes introduced the TERRIER BT-3, which employed beam and tail control technology providing higher speed and more range. The HT-3 followed with semi-active homing to improve accuracy and higher target hit probability. In 1955, TARTAR was initiated. Design changes, improved rocket motor, and the guidance system enabled it to be launched from smaller ships. In the 1960s, the first in the family of STANDARD Missiles, the SM-1 Mod 0, was introduced. Amidst the space race, an abundance of new and maturing technologies emerged ready for military application. The introduction of the SM-1 MR/ER in 1965 implemented technological advances incorporating semi-conductor technology and larger thrust rocket motors. The SM-2 was later developed specifically for use in the AEGIS system, requiring guidance system compatibility with the TERRIER and TARTAR shipboard systems.

In today's environment of highly sophisticated and complex warfare, where a single failure can destroy combat resources, bring about undesirable political consequences, and most importantly imperil human life, it is imperative that program management functions be executed perfectly using the best practices available. PEO TSC-M/L achieves such performance while evolving the STANDARD Missile Program to meet the Navy's needs, and effectively managing the Program through the application of technological changes and best practices. Among the best practices documented by the BMP survey team were the implementation of the Technical Risk Identification and Mitigation System to help identify, review, and mitigate risks associated with the transition from systems development to production; the Configuration Control Board, which streamlined the Directorate's change control process by adopting a more parallel process enabling a more timely approval cycle and avoiding expensive delays; the revision of the Missile Document MD-57104, allowing it to be a stand-alone, comprehensive document that consolidates systems engineering, quality, and reliability requirements; the Golden Round process, which thoroughly evaluates contractor processes to alleviate failures due to problems associated with manpower, methods, machine, and material; Government Program Office/Contractor Co-location, which improved communication by co-locating with its prime contractor allowing representatives from both organizations to operate and interact in close proximity to each other; and a web-based collaborative work environment to better manage program information and increase communication across the contractor/government teams.

PEO TSC-M/L is already addressing additional challenges of working with suppliers to reduce hardware cost, preserving its vendor base, and evolving both the STANDARD Missile and Vertical Launching System capabilities to meet increasingly sophisticated threats. The Directorate is committed to excellence in communication and exchanging best practices with other Program Offices and the entire U.S. industrial base. The BMP survey team considers the practices in this report to be among the best in industry and government.

POINT OF CONTACT:

For further information on items in this report, please contact:

Mr. Thomas Harvat
Management Analyst
Directorate for Missiles and Surface Launchers
(PEO TSC-M/L)
2341 Jefferson Davis Highway, Suite 700
Arlington, Virginia 22202
Phone: (703) 872-3707
Fax: (703) 872-3513
E-mail: harvatta@navsea.navy.mil

Section 2

Best Practices

Design

Configuration Control Board

The Directorate for Missiles and Surface Launchers Configuration Control Board streamlined the change control process by adopting a more parallel process to assure that all questions and issues are resolved before final submission to the Configuration Control Board. This enabled a more timely approval cycle and avoided expensive delays.

A traditional Configuration Control Board (CCB) process required CCB members to meet as required for reviewing and approving changes. The Directorate for Missiles and Surface Launchers (PEO TSC-M/L) recognized that this traditional CCB process needed to be revised and could be made more efficient by using current information technology. A new approach to the CCB process was established, and the cycle time for reviewing and approving changes was greatly reduced.

The CCB process, started by the originator who submitted the Engineering Change Proposal (ECP), was reviewed and revised by Board Members before the final approval in a serial process. The logistics of getting all the CCB members for the meeting was not only time consuming, but very costly. Sometimes it led to lengthy delays and often impacted production deliveries.

The current process is initiated by the ECP originator who notifies the Navy by posting a preliminary change document in the Corporate Data Management System (CDMS), a web-based information system. The Technical Representative (TechRep) of PEO TSC-M/L will then assign a leader to follow through the government review process. All review agents can access the ECP information on the CDMS and make comments to the assigned leader. The TechRep office consolidates comments and provides them to the ECP originator. The ECP originator addresses all comments, makes changes, and then submits the final ECP to the TechRep. After a final review by the TechRep, the ECP is submitted to the CCB. The PEO TSC-M/L's ECP Originator prepares the CCB directive and routes it back to the CCB members for final review and recommendation for final approval. The process ends with the CCB Chair approving the change. The benefits for this improved process are that the Navy's concerns are addressed well before the ECP is submitted to the CCB. It ensures all necessary supporting documentation, simulation, and testing are complete. It eliminates last minute surprises from reviewing agents, reduces investment in changes that will not receive Navy approval, and allows early allocation of resources by PEO TSC-M/L. Other major benefits include the reduction of cost and time associated with travel by both government and contractors, and improved timely approval of ECPs. An estimated cycle time reduction for the CCB process has been reduced from an average of one to six months to one to two weeks. It also emphasizes that by submitting the ECP correctly the first time, expensive delays are reduced.

Systems Engineering, Quality, and Reliability

The Directorate for Missiles and Surface Launchers has revised Missile Document, MD-57104. It is a stand-alone, comprehensive document that consolidates the Directorate's systems engineering, quality, and reliability requirements, and can be tailored for different programs and phases of the product life cycle.

With the implementation of Acquisition Reform in the mid-nineties, STANDARD Missile (SM) Document, MD-57104, became outdated, and needed revision to reflect the new acquisition approaches. The new revised document, MD-57104A, was generated to state what the Directorate expected from the contractors without specifying the "how-to" in meeting those expectations. It was written to allow contractors to deliver products with maximum flexibility.

The Acquisition Reform Initiative canceled many conventional "how-to" military Specifications and

Standards. It encouraged contractors to use industry best practices and commercial standards, as well as the performance based specifications when contracts are issued. MD-57104 was revised to reflect these changes. When updating MD-57104, an additional objective was to reduce the need for interpretation of requirements, and make it easier to understand and implement. The revision made it easy to flow-down to suppliers and clearly stated the customer's expectations.

MD-57104A is formatted to follow different phases of the acquisition life cycle, and a life cycle matrix reference is included in the document. MD-57104A encourages the use of commercial standards and best practices, and incorporates producibility, process Failure Mode and Effects Analysis (FMEA), Diminishing Manufacturing Sources and Material Shortages (DMSMS), traceability, and stockpile reliability surveillance. MD-57104A focuses in the areas of systems engineering, and quality and reliability requirements. Systems engineering requirements cover the Systems Engineering Program, Systems Engineering Master Plan (SEMP), interface management, risk management (the use of the Technical Risk Identification and Mitigation System [TRIMS] is suggested), cost as an independent variable (CAIV), and other essential systems engineering elements. The quality requirements detail the quality expectations in design and development, transition from development to production, and production to deployment phases. The reliability requirements cover reliability aspects in design and development, transition from development to production, and production phases of the program. Some of the requirements that address the transition to production phase are risk management, production quality, environmental stress screening, and random vibration.

MD-57104A is a stand-alone, comprehensive document that consolidates PEO TSC-M/L's systems engineering, quality, and reliability requirements, and can be tailored for different programs and different phases of the product life cycle. If properly implemented, it is a very cost-effective approach to sound systems engineering. When it is called out in contracts, it simplifies the Statement of Work and provides a single reference for consistent requirements in systems engineering, quality, and reliability for programs.

Test

Golden Round Missiles for Flight Testing

The Directorate for Missiles and Surface Launchers implemented the Golden Round process which thoroughly evaluates contractor processes to alleviate failures due to problems associated with manpower, methods, machine, and materials. Once the process proved successful, it was documented and became the pedigree process that could be used on any missile variant.

The Directorate for Missiles and Surface Launchers (PEO TSC-M/L) is responsible for the development and test of the STANDARD Missile-3 (SM-3) component of the AEGIS Ballistic Missile Defense (ABMD) system. As part of this effort, the missile must be tested with actual flight tests. These ABMD flight tests are very expensive (can be as much as $100M), with a limited number of missile and target assets, a difficult-to-secure test range, and the need for a significant number of Fleet assets. Each flight test receives high national visibility, and continued program funding depends on flight test success. The first three flights experienced failures due to workmanship, reliability issues, and defective hardware. One more failure would have jeopardized the program. To resolve and prevent these flight test issues, the PEO TSC-M/L embarked on a process meant to ensure success on future flights. This process became known as the Golden Round concept and was initiated to gain insight into contractor processes as a new series of test flights approached.

The Golden Round concept treats each flight as though it were manned. To this end, NASA and the space community were queried as to their processes. The results of these discussions led to a Golden Round Assessment Checklist. This checklist was the tool used to evaluate manpower, methods, machine, and materials. Manpower focused on qualification/training of personnel and identifying single point failures where only one skilled person existed to perform that critical operation. Methods addressed test, assembly (including the institution of "binning" the correct number and type of parts for that operation), the two-man rule which requires some operations to have a doer and an observer, and other operations and methodologies. Machine focused on tracking exactly who touched the missile and for what reason, as well as the test and repair history. Materials looked at material certification, stock control, and aiming for the mid-range of allowable tolerances for the materials. By using the Golden Round Assessment Checklist, the next four test flights were all successful including the first attempt at target intercept (direct hit).

The Golden Round process led to the development of a documented system, the Pedigree Program, to document and track every part/assembly as it moved through the stages of building and testing. The purpose of the Pedigree Program was to establish a formal system/process to maximize the probability of success for specified development flight tests and use the Golden Round process as the baseline. An innovative outcome of the Pedigree Program was that the contractor began documenting the as-built data for circuit card assemblies by taking high-resolution digital pictures of the assemblies. This proved invaluable in case of a failure mechanism that might be on one of the many assemblies. The digital pictures could be easily consulted to find things like part date codes (high failure rate components) or simply a part assembly problem. Thus, a digital picture could allow one missile to be recalled vice a blanket recall. Additionally, the pictures could also prove the problem was an isolated instance requiring no further action.

Simulation Accreditation Review Panel/ Verification, Validation, and Accreditation Process

The Simulation Accreditation Review Panel manages the Directorate for Missile and Surface Launchers' verification, validation, and accreditation process by providing independent technical oversight of verification and validation for modeling and simulation activities and documentation.

The Directorate for Missile and Surface Launchers (PEO TSC-M/L) recognized that implementing a robust process for Verification, Validation, and Accreditation (VV&A) of Modeling and Simulation (M&S) tools used to develop STANDARD Missile (SM) variants was critical to ensuring the product's effectiveness. This was judged particularly important given two established trends: 1) the increasing dependence on M&S, rather than expensive live testing, and 2) the increasing complexity and interdependence of future systems. Accordingly, a VV&A process was defined for PEO TSC-M/L that matched VV&A activities to the development lifecycle — from conceptual design and design reviews to developmental and operational tests through production and fielding. The process is administrated by the Simulation Accreditation Review Panel (SARP), which includes representatives from the PEO TSC-M/L, Applied Physics Laboratory (APL) as the Technical Direction Agent, Commander Operational Test and Evaluation Force, Navy laboratories Naval Surface Warfare Center (NSWC) Dahlgren and Naval Air Warfare Center (NAWC) China Lake, two major defense contractors (Lockheed Martin and Raytheon), and cognizant mission Program Offices.

The SM family is designed and developed using computer-based models and simulations. M&S tools are used throughout the lifecycle to perform trade-off studies to determine product requirements and specifications. The SARP was established to administer VV&A for the M&S. The SARP provides an independent, technical oversight of the VV&A process by defining plans, procedures, and responsibilities of various agents. It also verifies, validates, records, and accredits the M&S tools developed under the VV&A process. Prior to this formal accreditation process, the verification and validation activities were informal, subjective, and often undocumented. Simulation results could vary, and resources were expended to resolve differences. Also, subject matter experts were not always involved as development proceeded. The current Simulation Management Plan (SMP) was approved in 1999, and has been used as a guide for other Navy program VV&A approaches. This VV&A approach was used as the guide for the Navy Area Theater Ballistic Missile Defense (TBMD) Program, Navy Theater Wide (NTW) M&S Plan, NTW Accreditation Process Plan, and AEGIS Accreditation process. With the current SARP approach, all verification and validation activities are conducted according to defined plans, procedures, and responsibilities. Many benefits resulted from the VV&A process including:

- Cost reduction for fielding working systems by early detection of design errors through cross checking simulation results between contractors
- Cost savings from reduced actual SM flight tests replaced by trusted simulations
- Elimination of potential flight test failures due to a more formal and structured technical oversight

- M&S provided a solid basis for making development, manufacturing, and deployment decisions
- Ensured consistency of simulation test conditions and results among participating organizations
- Established a corporate memory including lessons learned for the SM systems by the formal VV&A efforts

By establishing the SARP, the PEO TSC-M/L effectively used M&S tools to detect shortcomings in different phases of the lifecycles of various missile systems, and applied corrective actions to mitigate program risks.

Management

Government Program Office/Contractor Co-location

In the mid-1990s, the Directorate for Missiles and Surface Launchers co-located with its prime contractor, the STANDARD Missile Company (now Raytheon). Representatives of both organizations operate in close proximity to each other and interact on a daily, if not hourly, basis. The co-location of the government program office and contractor has many benefits that directly lead to cost and schedule savings as well as an order of magnitude in the improvement of communication.

In the mid-1990s, the Directorate for Missiles and Surface Launchers (PEO TSC-M/L) co-located with its prime contractor, the STANDARD Missile Company (now Raytheon). Under this arrangement, the program management and prime contractor staffs share office space on the same floor of an Arlington, Virginia office building. In addition, PEO TSC-M/L has a small number of staff located at Raytheon's facility in Tucson, Arizona. This arrangement is unique for programs under PEO TSC.

Representatives of both organizations operate in close proximity to each other and interact on a daily, if not hourly, basis. An example of this integration is a daily 7:30 a.m. meeting of senior program management staff and contractor personnel. This meeting sets the tone and priorities for the day ahead. When required, provisions are made for government- or contractor-only meetings. Both organizations share conference rooms and office equipment. Several examples of the benefits of co-location include improved communication between PEO TSC-M/L and Raytheon staff; PEO TSC-M/L has faster access to contractor personnel, which results in faster answers to questions and resolution of critical issues; reduction in trips taken by PEO TSC-M/L staff to Raytheon's facility in Tucson (in general, travel has reduced from once a week, to once every several weeks, to once a month; since a work day is effectively lost traveling each way, there is a possible four-fold reduction in the PEO TSC-M/L staff travel time); and Raytheon representatives in Arlington sit in a dedicated Raytheon facility and have access to proprietary data that can be securely transferred directly to PEO TSC-M/L personnel if required, without concerns about sending proprietary data over non-secure systems such as e-mail. Many other benefits have been realized from co-location that PEO TSC-M/L has just begun to quantify.

Integrated Data Management

In 1998, the Directorate for Missiles and Surface Launchers moved from a developmental client-server based to a commercial-off-the-shelf internet-based Integrated Data Management System. This system allows the entire STANDARD Missile community to access data (such as contract and technical information) at any time or location. The Integrated Data Management System resulted in greater productivity by allowing easy access to important data by those who require it.

In 1998, the Directorate for Missiles and Surface Launchers (PEO TSC-M/L) moved from a developmental client-server based to a commercial-off-the-shelf (COTS) internet-based Integrated Data Management System (IDMS). This system allows the entire STANDARD Missile (SM) community (located in 11 states) to access data (such as contract and technical information) at any time or location. The previous system, implemented in 1995, was resource intensive on the computers of the day and required the use of a modem to access the data. The new Internet-based system gave PEO TSC-M/L the ability to access data from any location with Internet access.

Three broad areas make up the IDMS, including enterprise contracts repositories, project collaborations, and personal workspaces. The main repositories are the technical and community libraries. These areas allow users to store data in one central location rather than multiple areas, minimizing the chance of using outdated information. One type of data maintained in the IDMS system is Engineering Change Proposals (ECPs). ECPs are used to permanently change the design of a system. Persons with the responsibility of reviewing ECPs have a central location to view an ECP before passing it on to the Configuration Control Board (CCB) for a determination. Other uses of the IDMS are in the development of Requests for Proposals (RFPs), and the storage of technical documents within the program management office which allows for the electronic review and clearance of documents. Users also work on a variety of tasks using IDMS's private project sections. Individuals only have access to areas that they have "rights" to, which the originating user determines. Project sections can be developed without software coding and do not require a webmaster to establish. By July 2002, the system held nearly 54,000 documents for PEO TSC-M/L.

The use of IDMS has resulted in greater productivity by allowing easy access to important data by those who need it. This lowered the amount of travel required by program staff reducing travel costs and staff time lost in transit. This Internet-based system also allows users to adapt to new situations faster than with the older or non-existent data management system. PEO TSC-M/L has also discovered that using IDMS has reduced the amount of paper generated by 55 boxes per quarter for contractor data disseminated throughout the entire program office. In addition, PEO TSC-M/L reduced the time to develop an RFP from an average of nine to four months using the Internet-based system.

Mission Control Panel

The Directorate for Missiles and Surface Launchers instituted a rigorous process to increase the mission success of critical test demonstrations by actively using the Mission Control Panel process. This process provides a structure to ensure that critical issues involved in planning, preparation, and execution are satisfactorily resolved prior to test.

The Directorate for Missiles and Surface Launchers (PEO TSC-M/L) instituted a rigorous mission preparedness process to assist in mitigating the risk of missile test failures. The Mission Control Panel (MCP) is a structured process used to resolve critical issues involved in the planning, preparation, and execution of critical missile flight and ground tests prior to the actual test event. The MCP process assesses all aspects of the critical mission test to increase the likelihood of mission success. A typical MCP agenda addresses the following areas: Mission and Test Objectives Overview; Performance Predictions; Test Article (Missile) Readiness/Pedigree; Supporting Systems (Desert Ship and Vertical Launch System [VLS]) Readiness; Target Readiness; Range and Instrumentation Readiness; Test Execution and Test Documentation; Data Analysis Plans; and Panel Deliberation, Summary, and Action Items.

An MCP is typically held two to four weeks prior to a critical test. The MCP consists of a panel of senior government and industry leaders that 1) thoroughly review test readiness; 2) review degree of system readiness, and 3) assign action items to be completed prior to test. During the MCP process, a detailed review of the mission test is presented; performance predictions are documented; a review of support systems, target, and range readiness is evaluated; and a determination is made as to the readiness for missile flight test. A written report documents pertinent panel findings, action items, issues/concerns, and recommendations. Immediately prior to the actual test event, a subsequent readiness assessment, known as a Mission Readiness Review (MRR), is conducted to ensure all MCP recommendations and outstanding issues have been resolved. This final systems readiness review ensures that all concerns and issues have been resolved satisfactorily, and the system is ready to proceed with the critical test demonstration.

The MCP process is a standardized way of doing business for PEO TSC-M/L, and the up-front time and effort associated with the MCP process is believed to pay huge dividends in mitigating the risk of potential system test failures. PEO TSC-M/L recognizes that one of the major benefits of the MCP process is in preparing for presentation to the panel itself — the process requires test participants to think through each aspect of the test procedure and demonstrate hardware and mission preparedness to proceed with the execution of the test. The MCP process also provides a unique opportunity for the free exchange of corporate knowledge among senior leadership and mid-level managers as they prepare for final test preparations. Missile flight tests provide just one opportunity for many complex elements to come together to achieve mission success. The cost of failure is high for an exacting program such as STANDARD Missile (SM), both in dollars and schedule delays. The cost to conduct a missile test can be as high as tens of millions of dollars plus the cost of the test missile. Schedule delays associated with test failures are measured in terms of months, not days or weeks. Repeated system test failures can do irreparable harm to a program office's reputation and its viability as a program. Methodical and rigorous process controls alleviate the risk associated with test failures by detecting potential points of failure and correcting them in advance of a critical mission test. The MCP process and lessons learned from test events are formally documented in PEO TSC-M/L's Instruction 3000.1 dated November 15, 1999.

Production/R&D Memorandum of Understanding

The Directorate for Missiles and Surface Launchers is currently engaged in discussions for two Memorandums of Understanding with the countries of Germany, Canada, and the Netherlands. These Memorandums of Understanding seek to establish cooperative programs between these countries and the U. S. Navy STANDARD Missile production and R&D programs.

The Directorate for Missiles and Surface Launchers (PEO TSC-M/L) is currently engaged in discussions with Germany, Canada, and the Netherlands for a Memorandum of Understanding (MOU) for the purchase of STANDARD Missiles (SMs). The typical method of sales to other countries is through Foreign Military Sales (FMS). The FMS program represents a one-time transaction in a buyer/seller relationship. The purchasing country has no voice in system changes, and must pay for any R&D required for their use. Only the U.S. Navy requirements are considered in upgrades and improvements. The FMS method does not allow for combined buying power of multiple procurements, and administration and offset fees are charged. This method of sales results in costing the allied countries time and money trying to adapt the missiles to their particular requirements.

Two separate MOUs are in process — one for R&D, one for production units. These MOUs allow the buyer to be part of the process for product improvements and upgrades, thereby avoiding additional costs when changes are required for their use. When the allies are part of the R&D effort, they

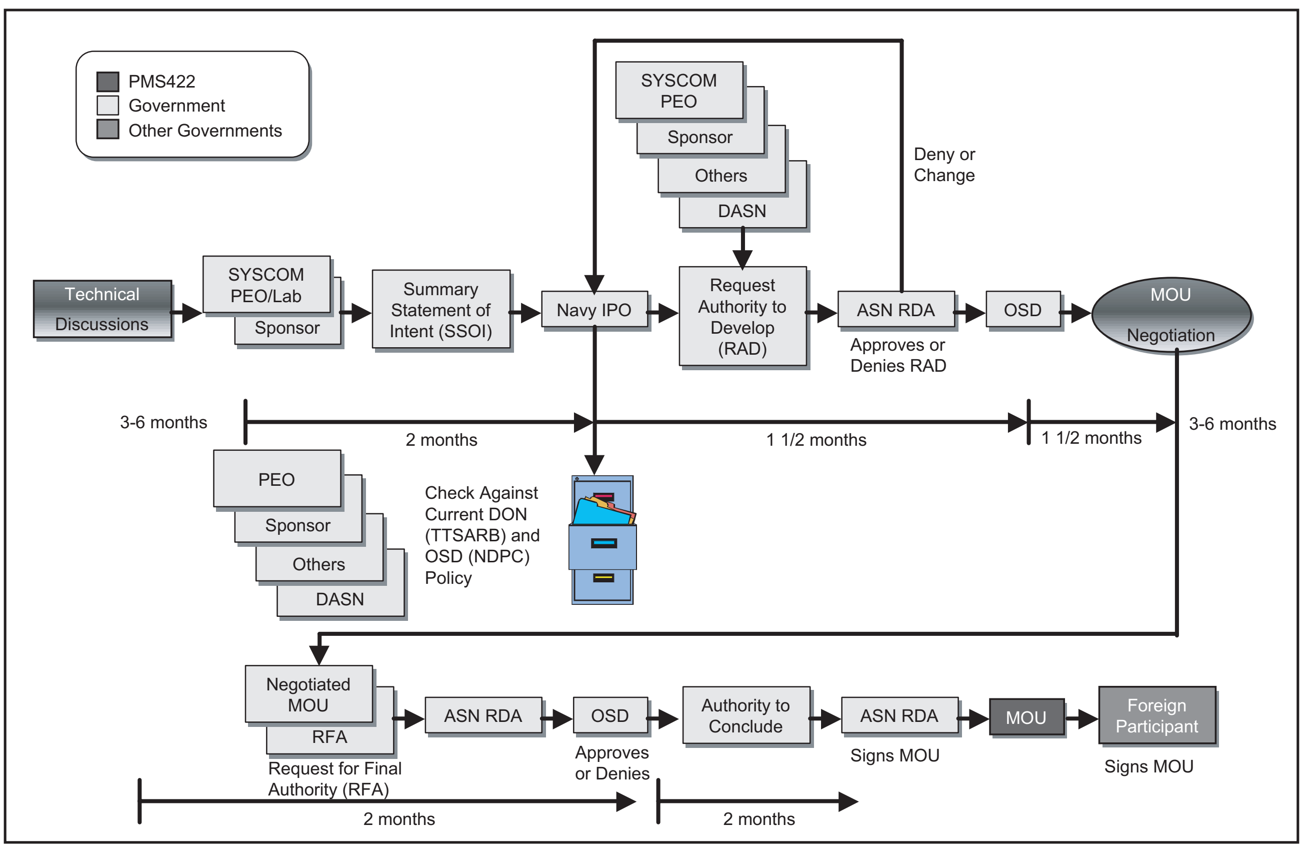


Figure 2-1. MOU Development Process

benefit from having a say in the requirements as they are developed. The production MOU sets up five-year procurement that guarantees an agreed upon number of units over that time. The production MOU allows for combined procurements, which lowers the cost to all involved, stabilizing production cycles and permits more effective planning in subsequent procurements. Configurations and logistics are synchronized, allowing for more insight into production and provisioning requirements for future builds. The MOU development process (Figure 2-1) identifies the involvement by all parties in the process. The most obvious benefit of this program is the synergy associated with the world market collaborative effort possible in this process. PEO TSC-M/L can schedule and budget many years down the road for their procurement requirements as a whole, as opposed to procurement cycles that require contingencies causing delays in procurement schedules and increased costs.

Program Critical Task List

The Directorate for Missiles and Surface Launchers' Program Critical Task List is an automated system that details the entire process of building a STANDARD Missile, delineated by 69 Work Breakdown Structure categories, to provide detailed spend plans, improved accounting, reporting, eased tasking, and management of work.

The Directorate for Missiles and Surface Launchers (PEO TSC-M/L) tasks many Navy Field Activities to perform work for STANDARD Missile (SM) design, production, testing and support via SEATASKs. Historically, the Field Activities suggested and submitted proposals for SEATASK work to the Program Office. Results were inconsistent and sometimes had overlapped tasks. To address this problem, each Field Activity was assigned a core competency and corresponding work tasks, but the one-to-one mapping did not work in most cases. Reporting and accounting were entirely manual processes. In an effort to streamline the process, PEO TSC-M/L developed considerably more than just a centralized and improved process for tasking Field Activities via SEATASKs. The end result was the Program Critical Task List (PCTL), an automated system that details the entire process of design, development, production and support of SMs, and provides detailed spend plans, improved accounting, reporting, eased tasking, and management of work.

To develop the PCTL, PEO TSC-M/L identified 69 Work Breakdown Structure (WBS) functional processes within the SM lifecycle, depicting the responsibilities and workflow within the entire SM community. Table 2-1 shows a sample view of PCTL, an MS Access database showing several of the WBS functions. For each WBS function, PEO TSC-M/L detailed the process to complete the function in a flow chart and specified required inputs, outputs, and points of contact (POCs). One of the 69 WBS function's processes is shown in Figure 2-2.

The PCTL system has been flexible enough to accommodate new fields, additional tasks and tests, new data, and the entire Vertical Launch System (VLS) lifecycle when it became part of the PEO TSC-M/L. PCTL was recently upgraded to run on a server so that Field Activities can submit proposals and costing information for specific steps of a process within a WBS function during the budget cycle. This eliminated overlap and inconsistencies, and eased workload and planning for subsequent years at the PEO TSC-M/L and Field Activities. Reporting is more flexible with reports by activity, function, functional category, and field activity now in a centralized database.

Life-Cycle Activity (Function ID)	Program Critical Task List Descriptions	Lead Functional Agency	Primary 422 POCs
In-Service Engineering			
ISE-1	Identify maintenance requirements	ISEA	E5
ISE-2	Identify/validate PHS&T requirements	ISEA	E5
ISE-3	Perform weapon system interface assessment	ISEA	E5
ISE-4	Assess and resolve operational issues Conduct failure investigation and analysis	ISEA	E5
ISE-5	Manage inventories and fleet loadout	ISEA	E5
ISE-6	Perform quality evaluation	ISEA	E5
ISE-7	Inspect fleet return missiles	ISEA	E5
ISE-8	Repair missiles	ISEA	E5
ISE-9	Manage end execute disposal/demil of missiles	ISEA	E5
ISE-10	Manage spares	ISEA	E5
ISE-11	Assess performance/reliability	ISEA	E4 & E5

Table 2-1. PCTL Matrix

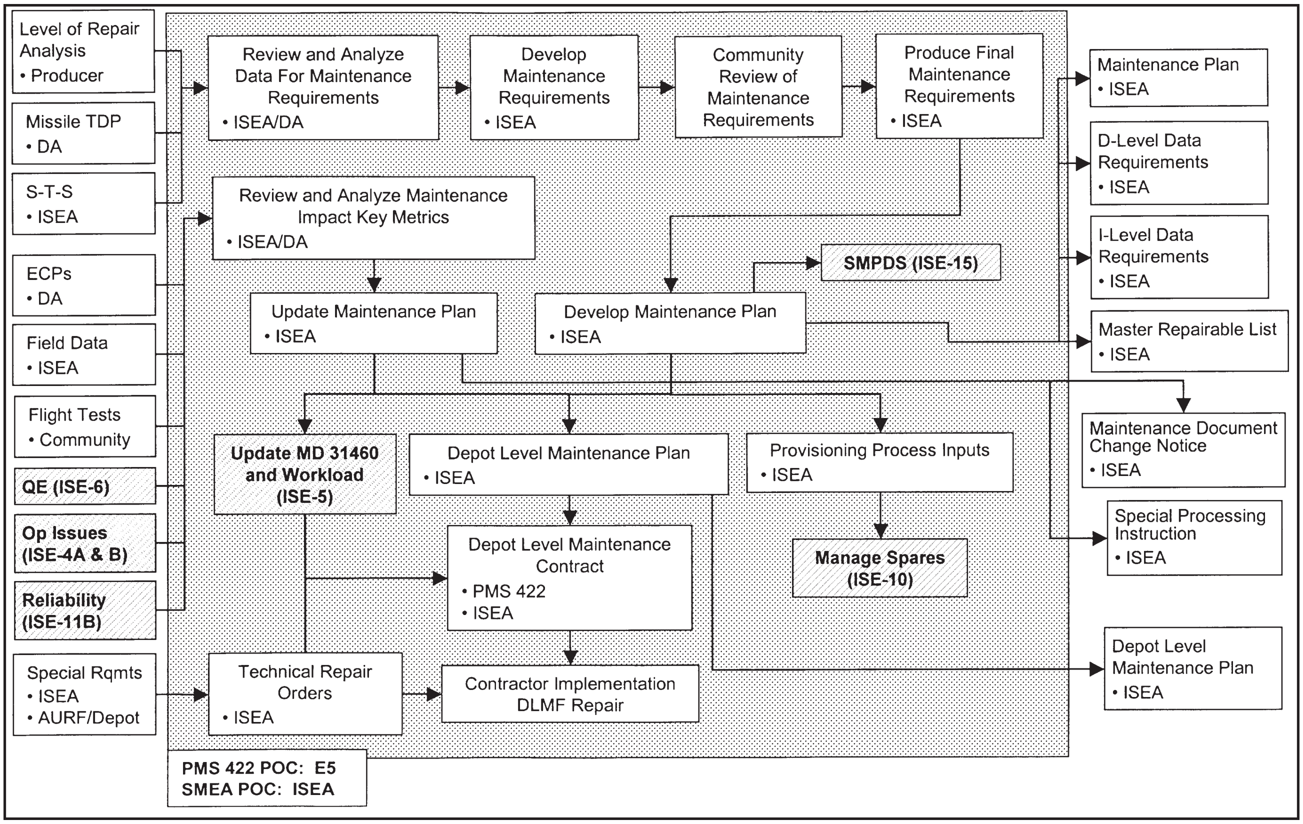


Figure 2-2. Sample Process Within PCTL Matrix

Documenting all of the WBS functional processes has been one of the key benefits. PEO TSC-M/L can now manage the entire work process more effectively including consolidation of surface Launch Systems and SMs. Tasking Field Activities is now easier for the Program Manager and Field Activities. The detailed processes provide more specific proposals and clearer spend plans. Reviewing real time budgets and costs is faster and can be done in lower-level detail with greater flexibility. Beyond the harder-to-measure cost avoidance benefits, enhanced flexibility and ease of management, the entire budget cycle is now noticeably three months shorter with PCTL.

SM-3 Collaborative Engineering Work Environment

The Directorate for Missiles and Surface Launchers established a STANDARD Missile-3 Collaborative Engineering Work Environment to better manage program information and increase communication across the contractor/government team. The Collaborative Engineering Work Environment is a web-based collaborative workspace with secure, password protected access to the most current STANDARD Missile-3 Program information available twenty-four hours a day, seven days a week.

The complexity and configuration of the STANDARD Missile-3 (SM-3) requires the integrated effort of numerous contractor, supplier, and government teams. During 1998/1999, the Directorate for Missiles and Surface Launchers (PEO TSC-M/L) was faced with an increasingly difficult problem of coordinating and communicating programmatic information among the large numbers of contractor, supplier, and government personnel supporting the development and production of SM-3.

Other factors added to the complexity of managing the SM-3 Program, which included physically dispersed contractor and government locations with multiple time zones, large volumes and currency of information, and timely access to information. To assist in resolving these issues, PEO TSC-M/L developed a web-based collaborative site called the Collaborative Engineering Work Environment (CEWE). CEWE provides a secure (128-bit encryption) twenty-four hours-a-day forum for users to post and view program-wide status reports, financial information, and calendar events on a web browser anywhere. It also contains the latest version of common software, such as Microsoft Office, to ensure document sharing is feasible across platforms and sites. The site and user access is controlled from the Program Office. Limited access sub-groups can be created, and these groups can use the website to transfer large or sensitive documents between the individual group members, with team distribution via e-mail done by the CEWE. This relatively simple solution has improved information flow between the contractors, suppliers, and PEO TSC-M/L; fostered the sharing of information; increased communication; fostered a sense of teaming among the contractor/government teams; provided real-time access to information; eliminated currency issues; reduced e-mail activity; provided PEO TSC-M/L with more flexibility in terms of access to program information anytime/anywhere; and reduced much of PEO TSC-M/L's administrative burden associated with managing and synthesizing reports.

CEWE provides a space for all government and contractor team members of the SM-3 Program to post reports, meeting minutes, meeting notices, and share pertinent programmatic information. The site design makes it easy for users with appropriate privileges to post content to the site without third party intervention. CEWE provides a flexible and easy way for SM-3 Program team members to access programmatic information on a timely basis, assuring them that the most current information available is being accessed. Features of CEWE include a document repository, discussion threads, calendar function, and a "what's new," which lists all new items posted since the user's last login. CEWE is an innovative approach to traditional program management in that it provides greater access to program information for all team members. This open philosophy provides greater benefits to the program by fostering communication and leveraging the intellectual assets of the entire team. By implementing CEWE, PEO TSC-M/L has moved toward a paperless environment.

Strategic Planning and Technology Management

The Directorate for Missiles and Surface Launchers recently completed a Future STANDARD Missile Strategy and corresponding Technology Management process to identify and use new technology and process priorities for insertion into its current and future programs. Documenting this process has benefitted the Directorate in better planning and a more agile and effective response to funding opportunities and collaboration.

The Directorate for Missiles and Surface Launchers (PEO TSC-M/L) implemented a new Future STANDARD Missile Strategy (FSMS) Technology Management process to identify and use new technology and processes for its current and future programs. Previously, new technology requirements were identified individually in an ad-hoc manner.

PEO TSC-M/L's new process began with product teams conducting classified studies to identify common issues and create a baseline analysis, the FSMS, so that an appropriate investment strategy would be based on the study findings. Specifically, FSMS identified technology priorities, including products ready for insertion and ready to be considered for insertion; developed technology roadmaps with major milestones, appropriate funding sources, and collaborations; established when new technology should be inserted into various STANDARD Missile (SM) programs; delineated near-term plans

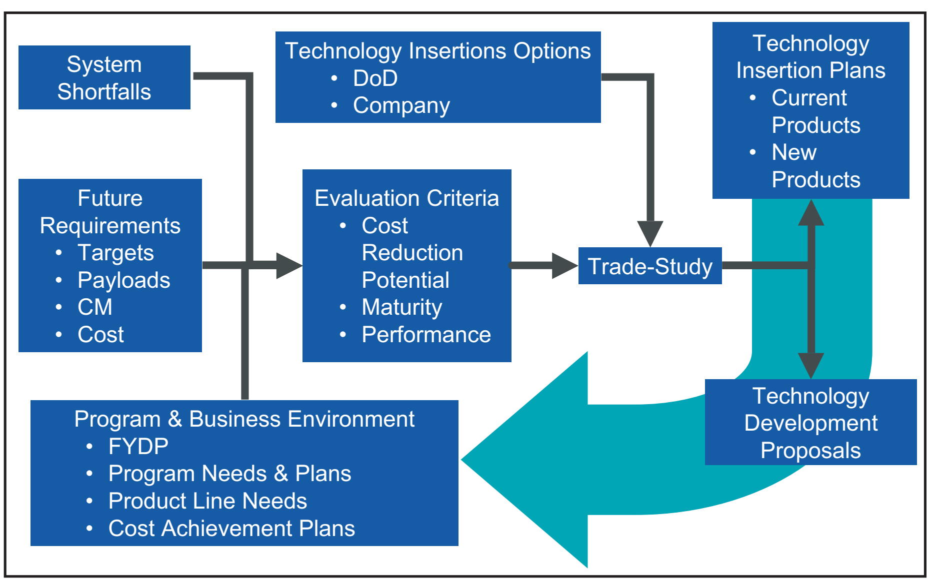


Figure 2-3. Technology Evaluation and Selection Process

of action; determined that SM improvements could not just be focused on capability and affordability, but also needed to address availability and reliability to be effective; and established an ongoing Technology Management Process to keep the FSMS up-to-date, and ensure smooth implementation of the strategy as the environment, organization, and objectives changed.

Documenting the FSMS has been beneficial in allowing the PEO TSC-M/L to better plan and more quickly and effectively respond to funding opportunities and collaboration. The real metrics on the effectiveness of strategic planning will come from the implementation of PEO TSC-M/L's Technology Management Process. The ongoing Technology Management Process will pull technology from the field, encourage innovation, push technology based on requirements, exploit investment opportunities and collaborations, do strategic planning, evaluate and monitor processes, and manage the technology roadmaps. PEO TSC-M/L's process for evaluating and selecting new technology to insert into its programs is shown in Figure 2-3. The ongoing Technology Management Process is maintained by Integrated Process Teams (IPTs) with members from PEO TSC-M/L, Government Field Agencies, and contractor personnel, on varying levels focused on specific technical areas and coordinated by a central R&D Leadership Board.

Technical Instruction Process

The Directorate for Missiles and Surface Launchers aggressively attacked and solved problems and delays associated with the Technical Instruction process used as a "short-term" contractual vehicle to task and fund a contractor to perform specific work when results expected are not well defined.

The Directorate for Missiles and Surface Launchers (PEO TSC-M/L) uses Technical Instructions (TIs) as a contract vehicle to facilitate execution of effort by the contractor to perform engineering trade studies, develop product improvement concepts, support flight tests, and solve production problems. Many undesirable features of the process existed that PEO TSC-M/L's Technical Representative (TechRep) sought to correct, including no single PEO TSC-M/L point of contact (POC) for all TIs, which resulted in a lengthy approval process; no standard format for the TI document; no central TI tracking system; no standard monthly reporting format; and no timely award fee process.

The TI process improvements addressed Administration, Management and Insight, and Award Fee. Under Administration, improvements included the establishment of a central POC at PEO TSC-M/L; implementation of one tracking system for all TIs; the establishment of standard reporting formats for both the PEO TSC-M/L and the contractor; and the standardization of the TI document (now three pages versus approximately 20). With improvements in Management and Insight, the contractor and Tech Rep jointly draft and revise the TIs, which are now managed at the TI level versus the associated higher level contract line item. Improvements in Award Fee brought about accelerated Navy field activity review; quicker feedback and fee to contractor; and PEO TSC-M/L and the TechRep provide the award fee assessment.

The old TI methodology allowed ten of 30 TIs to be overspent, past due, or out-of-scope of desired work. The new TI methodology has allowed only one of 42 TIs to experience one of the above problems, and that overrun was due to program cancellation. Another major improvement is continuing a TI past its original execution period. It is a rule that work must stop until the new TI is in place, and often this process was not started until the original TI had expired. Now the team is proactive and the new TI is in place as the old one expires, which alleviates a stop in work. Also, due to the team management/execution philosophy, the time to process a TI and get it in place to allow the work to begin has dropped from approximately two months to five days, which is now the new goal for every TI. This five-day goal has only been missed once in two years since the improvements were implemented. Considering that 20 TIs are processed each month, this savings in time is very valuable. The reporting and tracking improvements have also allowed reduction of the award fee process by approximately two months, including financial and technical reporting. Since the award fee process is intended to incentivize the contractor for good performance, this is a win-win situation for both the contractor and PEO TSC-M/L.

Figure 2-4. TechRep Mission

Technical Representative Office

The Directorate for Missiles and Surface Launchers Program Management Office is co-located with its prime contractor, Raytheon, in Raytheon office space. This arrangement has been extended to the Raytheon production facilities in Tucson, Arizona by establishing the Technical Representative Office, which acts as the Directorate's Production Agent.

The Directorate for Missiles and Surface Launchers (PEO TSC-M/L) Program Management Office is co-located with its prime contractor, Raytheon, in Raytheon office space. This arrangement improves communication between the government and the prime contractor which indicates the commitment to each other for a long-term business/teaming relationship, and allows resources to be applied to a shared vision. This arrangement has been extended to the Raytheon production facilities in Tucson, Arizona by establishing the Technical Representative (TechRep) Office.

The TechRep Office existed in various forms over the years, but by 1999 was severely diminished in its role and benefit to PEO TSC-M/L. The PEO TSC-M/L chartered a team to reinvigorate the TechRep role as the Program Manager's representative at the production site. The TechRep Office now acts as PEO TSC-M/L's Production Agent and its goals are to facilitate better communication across the STANDARD Missile (SM) product lines; interact with Integrated Process Team (IPT) representatives within other Tucson programs; provide timely and thorough technical information exchange and decision making; and improve interactions between Raytheon and all other government activities.

The TechRep Office has become a robust organization able to work across SM programs with insight into both PEO TSC-M/L's and Raytheon's processes, programs, and personnel to improve execution of PEO TSC-M/L's work. It is aligned with the new PEO TSC-M/L culture of sharing information and joint government and contractor success, as shown in Figure 2-4.

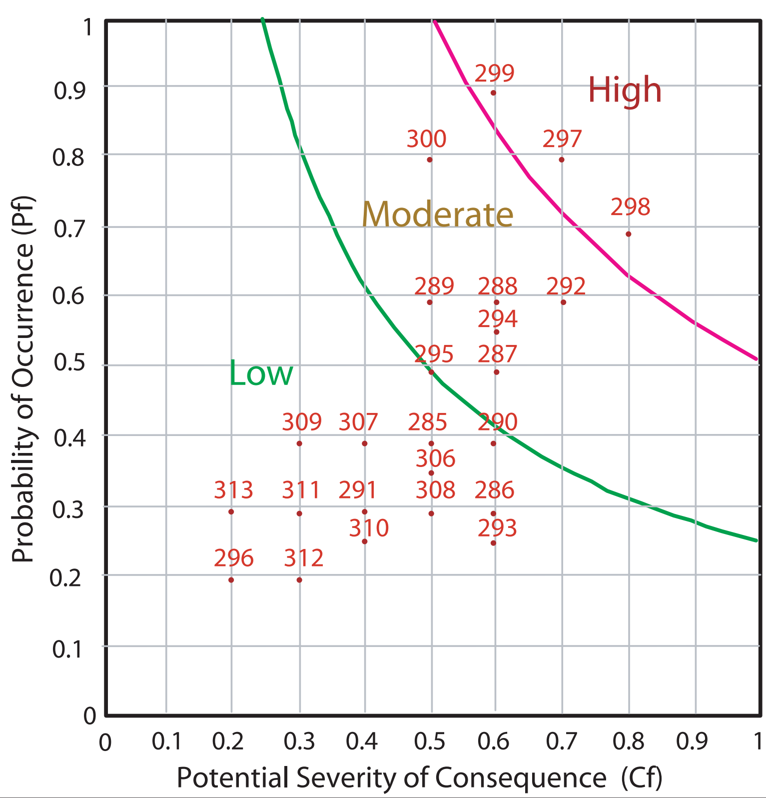
There have been many benefits. The TechRep is a dedicated technical authority empowered by PEO TSC-M/L to make technical decisions and recommendations, which speeds decisions and improves communication. The TechRep expertise is used real time to resolve issues across all programs and to surface major problems to PEO TSC-M/L for early resolution from overall programmatic perspective. The TechRep insight into contractor processes and program execution makes PEO TSC-M/L a better buyer and likewise, its understanding of government processes enables it to remove roadblocks into which the contractor has no insight. The programs also have seen better control of government-owned materials and furnished equipment. Additional benefits include reduced flight test risks through direct involvement; more effective planning for tests and Engineering Change Proposals (ECPs); improved supplier visits; wider government participation; production tracking across programs; enhanced reporting with greater insight; and better team work.

Technical Risk Identification and Mitigation System

The Directorate for Missiles and Surface Launchers implemented the Technical Risk Identification and Mitigation System to assist in identifying, reviewing, and mitigating risks associated with the transition from system development to production. This methodology and toolset provide a disciplined, thorough, and systematic approach to risk identification.

In the mid-1990s, the Directorate for Missiles and Surface Launchers (PEO TSC-M/L) implemented the Technical Risk Identification and Mitigation System (TRIMS) to enhance the STANDARD Missile-2 (SM-2) Block IVA and STANDARD Missile-3 (SM-3) risk management program. Prior to using TRIMS, PEO TSC-M/L relied solely on the standard contractor-developed risk management process. The contractor risk management process provided a good tool for tracking risk areas, but fell short of a true risk management system capable of identifying risk areas, managing the mitigation of risks, accessing templates and best practices, and providing predictive visibility. The contractor risk management process focused primarily on the product/technical risk associated with program development. The TRIMS methodology and toolset provided a more robust and holistic view of program risk issues by focusing on systems engineering processes. This different focus contributed significantly to the identification of new risk issues for the SM-2 Block IVA program. A full 50 percent of the high- to moderate-risk issues, and their probability of occurrence and the potential severity of consequence, were identified by TRIMS assessments (Figure 2-5). The TRIMS assessment identified three high-risk issues that were previously not identified by the contractor risk management system.

TRIMS is a disciplined process for continuously examining program elements and identifying new risk issues that need to be managed. The TRIMS methodology and toolset are comprised of critical path risk templates (Figure 2-6), which provide a series of program elements that assist in identifying potential program risk factors. Seven hundred questions in 70 templates covering the entire systems engineering process provide the basis for program risk assessment. TRIMS questions can



Rank/Risk #		Risk Issue
1.	297	Inadequate Eval of AUR Facility
2.	298	Matl/Process Change Notification
3.	299	ESS Profiles
4.	292	Critical Manufacturing Tech
5.	300	Critical Process ID/ Capability
6.	289	Requirements Flowdown to Blk IV
7.	295	No Plans for PRRs at COEs
8.	290	Classification of Characteristics
9.	285	DVT Testing - Qual test rigor
10.	306	Rate Capability of Suppliers
11.	286	Near-Miss Shock Test failure (LRIP)
12.	293	Subcontractor/Supplier Mgmt
13.	307	TE Reliability - System calibration
14.	308	New Critical Supplier - Aerojet
15.	291	Nuclear Survivability Performance
16.	309	Availability of Critical LLM
17.	310	Component /Processes - LRIP
18	311	Delivery schedule test bottleneck
19.	312	Establish baselines prior to LRIP
20.	313	Hazardous Matls Used in Product
21.	296	IPT Communication - SM Variants

Figure 2-5. Risk Issues Identified by TRIMS

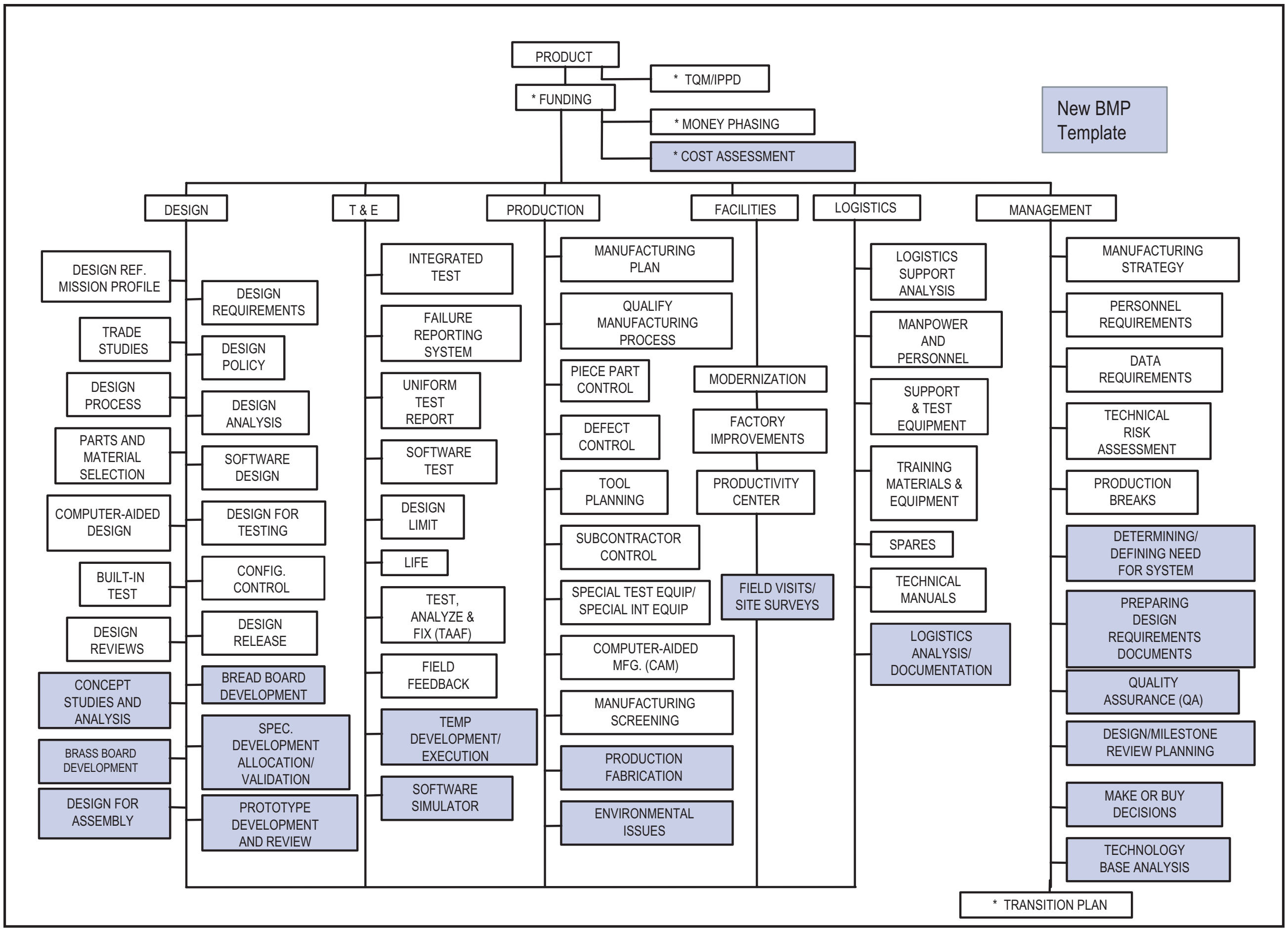


Figure 2-6. Critical Path Risk Templates

be tailored and, in the case of PEO TSC-M/L, the questions were tailored specifically to the SM-2 Block IVA program. The TRIMS toolset allows a detailed drill-down into the templates, and prompts questions specific to that program element. Similarly, the SM-3 program further instituted the TRIMS methodology and toolset, resulting in a rigorous and effective risk management process.

The TRIMS-based process supplements the existing contractor risk management process and provides the following distinct advantages:

- Detailed, tangible, tailored questions and templates
- Systems engineering process focus
- Broad, thorough scope of program elements
- Impetus to periodically/continuously look for risk and reassess risk
- Database/template of best practices to benchmark
- Objective, repetitive criteria
- De-facto training and education of contractor management

As a result of TRIMS-based risk identification, PEO TSC-M/L implemented significant actions aimed at mitigating risk to the program. Among the actions taken were the new adjunct sensors redesign, more rigorous producibility analysis across SM, new test equipment, emphasis and improvements in sub-contract management processes, and the establishment of an Independent Software Engineering Team to address software risks. Prior to the TRIMS implementation, software was not even identified as a risk issue for the program, but has proved to be a major focus area. The TRIMS methodology and toolset provide a proactive approach to risk management by actively engaging program elements and uncovering risk issues early in the development cycle.

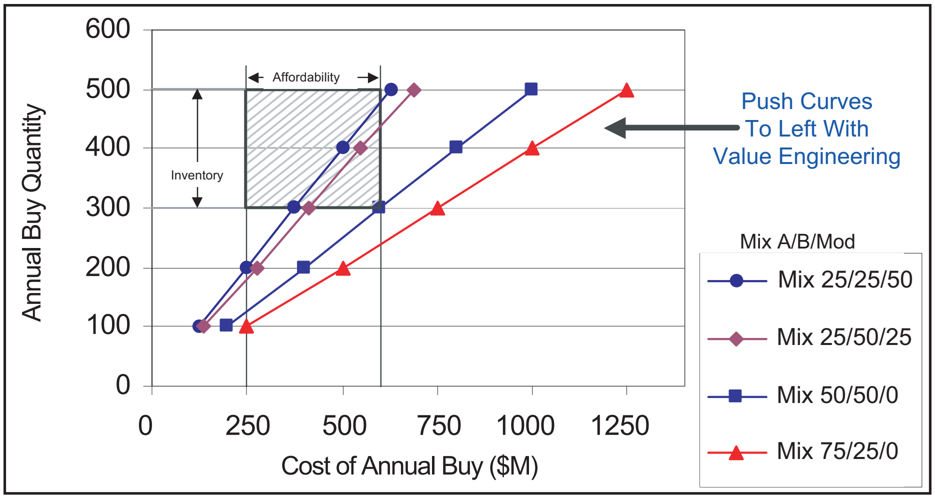


Figure 2-7. Affordability/Inventory Considerations

Value Engineering Program

Prior to the implementation of the Directorate for Missiles and Surface Launchers' Value Engineering Program, the price of missiles was steadily increasing and budgets were decreasing. In order to continue to purchase missiles in sufficient quantities to meet Fleet requirements, the price of the missile had to be reduced. The Directorate leveraged both government and contractor resources to attack high cost areas of the missile with its Value Engineering Program.

The Directorate for Missiles and Surface Launchers' (PEO TSC-M/L's) Value Engineering Program is a cooperative effort initiated by PEO TSC-M/L, to jointly fund cost savings initiative investigations and share resultant savings with the contractor. Prior to the implementation of the Value Engineering Program, the price of missiles was steadily increasing and budgets were decreasing. In order to continue to purchase missiles in sufficient quantities to meet Fleet requirements, the price of the missile had to be reduced. PEO TSC-M/L leveraged both government and contractor resources to attack high cost areas of the missile with its Value Engineering Program.

PEO TSC-M/L and the contractors share up-front costs and subsequent savings among the initiatives. Good working relationships and government initiation of this program were essential to build trust and get the program started. Value Engineering Proposals are executed at the contractor facility, through a normal Engineering Change Proposal (ECP), but are called Value Engineering Change Proposals (VECPs). VECPs receive streamlined decision making by the Program Executive Office and contracts teams, and must include clearly detailed cost and technical benefits; well-defined, non-recurring engineering effort estimates with enough lead time to meet the proposed start date; evenly shared proposals if other programs are involved; and realistic production cut-in dates to avoid surprises in budgeting and contracting processes. Figure 2-7 details affordability and inventory considerations within the PEO TSC-M/L. By varying inventory ratios and implementing the VECPs, PEO TSC-M/L is able to keep the annual costs down with less sensitivity to the quantity purchased (i.e., to change the slope of the curves).

VECPs typically focus in development and production areas, and are designed for continuing manufacturing sources, backfit and forward fit, commonality among products, competitive vendor selection and post-service life, more efficiency in meeting operator's needs, and replacing obsolete parts. While cost savings are the primary goal, increased performance and availability of parts are almost always seen as well. The PEO TSC-M/L and contractors have been widely recognized for their VECP successes and saved $85 Million to date across STANDARD Missile (SM) programs, which is substantial for one office when compared to other federal value engineering efforts. The return on investment to date has been about 10 to15, compared to an average 25 percent reduction in government VE programs (SAVE 1997 International Conference Proceedings, Volume XXXI, www.value-engineering.com/federalresults.htm).

Design Verification and Independent Testing

In the special case of flight tests, which are prohibitively expensive ($20 Million per test) and politically disastrous if they fail, design verification and testing by an independent agent in a ground-based program are essential to avoid failures.

The Directorate for Missiles and Surface Launchers (PEO TSC-M/L) implemented an aggressive ground testing approach to verify the missile design and functionality. Other than the accepted tests performed by the prime contractor, PEO TSC-M/L instituted a two-tier, ground-based testing to ensure total functionality of the missile prior to conducting expensive flight tests.

This ground-based testing is performed by the design agent and an independent government test group, the Technical Direction Agent, to further reduce risk. The second, and independent, testing uses different personnel, test set-up, and test methods. Due to this variation in approach, and the fact that this is a separate "set of eyes," additional problems surface that are not uncovered by the design agent. It further provides additional resources to find solutions to problems. Ensuring, as much as possible, the functionality of the missile prior to flight testing can save huge sums of money, time, and unnecessary repeated tests. It has been estimated that one failed flight test alone can cost the Directorate $20 Million, not including the cost of the missile.

Several major benefits of this independent government testing, performed by the Technical Direction Agent, include providing functional verification of flight software; assessing flight readiness; evaluating "off-nominal" conditions as these may affect the host combat system that utilizes the missile; confirming problems identified by the design agent; providing data to validate models in high fidelity digital simulations (in this case, typically meaning a six degree of freedom model); and analyzing flight test data. All of this added effort is not conducted behind closed doors. Rather, an open teaming arrangement exists between the design agent and the Technical Direction Agent that proved to be most effective in achieving the common goal of successful flight tests.

Further benefits are realized throughout the system lifecycle by using independent testing. It provides the capability to achieve risk reduction and perform critical experiments, perform development engineering, evaluate overall system performance, evaluate flight test readiness, and perform production unit screening and other Fleet testing. For one missile variant, the government independent test facility was available more than a year before the design agent's facility, allowing the discovery of significant software and integration problems before the first test flight. For another missile variant, the independent facility tests identified the failure mechanism of a flight test failure. The tests enabled software to be developed to correct the problem before the next test flight.

The results of this testing approach have been a reduction in flight testing failures and the associated costs, reduction in schedule slippages, increased confidence in the missile itself, and rapid evaluation of problems that surfaced so corrective action time was greatly enhanced. All of these benefits lead to a better reputation regarding the effectiveness of PEO TSC-M/L as a whole.

Section 3

Information

Test

Failure Reporting and Corrective Action System

The Directorate for Missiles and Surface Launchers' in-service Failure Reporting and Corrective Action System is a unique collaborative system which improves cycle time and reduces redundant efforts. This system is also an excellent resource for the retrieval of historical data.

The Directorate for Missiles and Surface Launchers (PEO TSC-M/L) developed a unique Failure Reporting and Corrective Action System (FRACAS). In the past, participation by all the in-service elements was limited, and a formal data tracking system did not exist. Failures and resolutions to issues were typically dealt with in a less concurrent engineering fashion, which caused duplication of efforts by multiple agents in parallel without collaborative efforts costing the Navy time and money. A formal historical database did not exist for trend identification and resolutions.

The new FRACAS is a formalized program for reporting and correcting in-service missile failures. The process involves full participation of representatives from all associated engineering agents, including the Technical Design Agent (TDA), Round Design Agent (RDA), In-Service Engineering Agent (ISEA), and Item Engineering Agents (EAs). The process involves extensive use of web-based information sharing via LIVELINK (web-based database) and frequent teleconferences to discuss and close out Trouble Reports (TRs) issued for every missile problem discovered in the Fleet, maintenance facilities, and elsewhere in the lifecycle of the missile. This provides a process in which the STANDARD Missile (SM) community can work and track in-service issues to resolution. The developed FRACAS encompasses the entire post production lifecycle and involves all organizations in a concurrent engineering effort. Stronger accountability and coordination now exist, eliminating the redundant efforts by multiple agents. Historical data retention and the promotion of data sharing can now be realized. The process also includes ease of data entry via e-mail without formal, complicated efforts thereby obtaining information that may have never been entered in the past. The ISEA formally enters the data into the database. The process includes risk analyses to prioritize the corrective action process. Data sources range from Casualty Reports (CASREPs) and mishap flight failures to Depot Level maintenances and all data retrieved in between. The ISEA enters the TR into the web-based database. Issues are prioritized and risks assigned during the FRACAS telephone conference. The corrective actions are outlined, and reports are generated for review. Telephone conferences are conducted every two weeks with on-site meetings at each site as required. The FRACAS team establishes work priorities and action items on every new TR based on these identified risks.

The FRACAS is a systems engineering approach, which has proven to streamline the process eliminating duplication of effort and bringing resolution to problems in a more improved fashion. All issues are tracked to resolution based on established, well defined risk registers. The database retains the information in a historical system for trend identification and allows reengineering efforts that help avoid future problems.

Test Equipment Roadmap

The Directorate for Missiles and Surface Launchers developed a roadmap for dealing with its test equipment problems, ranging from obsolescence to capability. This roadmap will help Program Managers budget for and prioritize test equipment issues and their corresponding corrective actions.

The test equipment currently being used to test STANDARD Missiles (SMs) in various stages of development and sustainment is old and causing obsolescence issues to surface. The number of variants and complexity levels of SMs are increasing. The cost to maintain the entire range of test capability on common platforms is becoming prohibitively expensive, which is driving the need to establish a test methodology and procurement plan that will focus on and keep pace with current and future production requirements. The older equipment is also running with out-dated software, and software developers and maintainers for these older systems are slowly becoming extinct.

The Directorate for Missiles and Surface Launchers (PEO TSC-M/l) developed a strategic plan for use in the development of SM test and test equipment procurement planning for all SM Programs. A time-phased budget for acquiring/developing proper test methodologies and equipment was laid out. The intent of the effort is to provide data and recommendations to the Program Manager for all test and test equipment related decisions. This test equipment roadmap will be used and maintained by both Raytheon and the SM Technical Representative (TechRep), and is considered a living document to be updated periodically.

The roadmap identifies new test equipment procurement, modifications, upgrade requirements, as well as where and when existing test equipment can be retired or withdrawn from the SM infrastructure. This eases lifecycle support resources that may be reprogrammed and used to support other emerging or existing SM test equipment requirements. Identification of future opportunities for cost sharing with international partners and other domestic programs will also be defined in the technology roadmap.

Production

Plastic Encapsulated Microcircuit Application

The Directorate for Missiles and Surface Launchers established an integrated process team to mitigate risk associated with the application of Plastic Encapsulated Microcircuits in STANDARD Missile hardware. The team established guidelines for the requirements based on the lifecycle environment profile of the hardware.

The Directorate for Missiles and Surface Launchers (PEO TSC- M/L) implemented a proactive program to manage the application of Plastic Encapsulated Microcircuits (PEMs) in STANDARD Missile (SM) hardware. With the declining share of defense microcircuit usage, reduction of military electronic suppliers in the commercial market, and the new approach of Acquisition Reform, the PEO TSC-M/L made a transition in the mid-1990s from using hermetically sealed microcircuits to PEMs for SM production. In 1997, a PEM Integrated Process Team (IPT) was chartered to mitigate the risk of PEM implementation.

The IPT membership consists of subject matter experts from different Navy activities and contractors including Naval Surface Warfare Center (NSWC) Dahlgren, NSWC Corona, Naval Air Warfare Center (NAWC) China Lake, Johns Hopkins Applied Physics Laboratory (APL), STANDARD Missile Company, Raytheon, and Motorola. Some of the major concerns associated with the use of PEMs are limited temperature range, lack of performance and reliability data, rapid obsolescence, new and emerging packaging material and methods, product variability, unqualified vendor data sheets, supplier variability, and unknown long-term reliability in application environment. The IPT's chosen approach to mitigate these risks was to proactively work with contractors to survey industry and capture best practices.

In 1997, the IPT issued "Guidelines for Implementation of Plastic Encapsulated Devices (PEDs) in STANDARD Missile Applications." These guidelines address part management requirements; part selection for moisture sensitivity; operating temperature range; lifecycle humidity performance; part qualification requirements; and supplier selection. This document is now imposed in SM contracts to assure common requirements for the insertion of PEMs into SM hardware. The IPT continues to monitor PEM development and remains proactive in addressing new, emerging PEM issues relating to stockpile-to-target environments and long-term dormancy issues. Some of the long-term dormancy issues involve plastic encapsulant material properties and moisture-related effect. The current focus of the IPT is to establish stockpile-to-target environmental conditions, investigate environmental profiles for packaging, handling, storage, and transportation, and update the guidelines to reflect these operational environmental requirements. Other current IPT efforts include developing higher level guidelines to tailor PEMs requirements for other services and studying new processes that protect microcircuits at the die level, which could reduce many PEM failure mechanisms.

The PEM IPT effort proved to be an effective way to mitigate risk associated with PEM implementation. It should be noted that a proactive approach, continuous market research for emerging technology, and understanding the application environment are the keys for risk avoidance.

Reliability Model

In 1999, the Directorate for Missiles and Surface Launchers experienced reliability problems with the STANDARD Missile, and developed a Reliability Model that has constantly evolved from its beginnings in 1999. This Reliability Model allows the Directorate to commit limited time and resources to what are determined to be the top causes of reliability degradation in its missiles. Several benefits and process changes have occurred since the creation of this Reliability Model.

In 1999, the Directorate for Missiles and Surface Launchers (PEO TSC-M/L) experienced reliability problems with the STANDARD Missile (SM). It concluded that it did not have a systematic approach for modeling the effects of variables such as heat, vibration, handling (dropping), age, and exposure to salt on the reliability of finished missiles. PEO TSC-M/L formed a team to identify a way to model reliability degradation for SMs in the Fleet.

PEO TSC-M/L created a joint group, the STANDARD Missile Assessment Reliability Team (SMART). SMART, comprised of government and industry representatives, established consistent reliability definitions and assessment methods for the SM community that accurately estimates and clarifies reliability for different missile variants and lifecycles and validates the methods to be recommended. SMART focused on SM-2 Block II and III variants, and created a Reliability Model that has continuously evolved from its beginning in 1999.

The Reliability Model takes into account factors such as overseas vs. Continental United States (CONUS) storage, missile age, and other factors to create scores shown over time as a model curve. New and revised model data points update the model over time. The model identifies trends in the missile population and permits PEO TSC-M/L to rank the top causes of reliability degradation. The ranking of potential missile problems allows PEO TSC-M/L to commit limited time and resources to what are determined to be the top causes of reliability degradation. In addition, a surface combatant ship contains an instrumented and inert SM to gather storage data. The data collected from this effort will refine the model further. PEO TSC-M/L also formed two groups to define the concepts for model use (Reliability Steering Group) and model analysis (Analysis Team). These groups report their findings to a group of Navy and SM contractor representatives who meet approximately twice a year to identify solutions to the problems identified by the model.

Several benefits and process changes have occurred since the creation of the Reliability Model. The model has shown that missile stockpile reliability is predicted to be lower than what had been traditionally reported. Further, the model identifies missile types that are below the reliability requirement called for by the Navy. With this information, the Navy can pull these missiles off surface combatant ships for inspection and repair. The model has also confirmed that age has a degradation effect on certain components within the missile (i.e., the auto pilot battery section). The model has also shown that overseas storage almost triples the predicted reliability degradation rate of a missile compared to CONUS storage, and that CONUS storage causes approximately the same predicted reliability degradation of a missile as storage on a surface combatant or auxiliary ship. Because of these discoveries, several actions have occurred to reduce the risk of stockpile degradation including informal storage site reviews, education on storage requirements at storage facilities, and the removal of SMs from one of the facilities.

Logistics

Workload Planning Process

The Directorate for Missiles and Surface Launchers developed a Workload Planning Process with other U.S. Navy activities to keep the required amount of STANDARD Missiles available for deployment and training while operating on a greatly reduced budget compared to the 1980s.

In the past, the Directorate for Missiles and Surface Launchers (PEO TSC-M/L) did not work closely with the Fleet to identify what specific missile types were needed for upcoming deployments. Resources were available to repair missiles as they were identified. With this type of repair budget, surface combatants had large numbers of missiles available to them when they deployed. By 1994, the budget for missile repair was too low to continue the practice of repairing all missiles as they arrived. At the same time, the U.S. Navy reduced the number of intermediate-level maintenance facilities from four to one. The PEO TSC-M/L developed a Workload Planning Process with other U.S. Navy activities to maintain the required amount of STANDARD Missiles (SMs) available for deployment and training while operating on a greatly reduced budget compared to the 1980s.

PEO TSC-M/L, with other Navy activities such as the Port Hueneme Division of the Naval Surface Warfare Center (PHD NSWC) and the Naval Ammunition Logistics Center, designed a new Workload Planning Process to meet the Fleet's SM requirements. PEO TSC-M/L tasked PHD NSWC to be the focal point for maintenance workload planning and management. The process operates similarly to a just-in-time inventory program, and considers multiple factors such as Fleet needs, budget limits, missile type reliability data, and priority requirements when determining what missiles will be sent to storage, repair, or for Fleet use. This process also considers more unique events when making logistical decisions, such as missile test firings which require telemetry equipment to be added to missiles, and the use of rocket motors nearing the end of their lives. It also works to include the repair requirements of foreign SM users, while at the same time not interfering with the needs of the U.S. Navy. PEO TSC-M/L's Workload Planning Process allows the U.S. Navy to fulfill the Fleet's SM needs for deployment and training while operating on a greatly reduced budget.

Management

Financial Management Policies and Procedures

The Directorate for Missiles and Surface Launchers developed a Financial Management Planning Process to manage the sales of missiles to foreign countries. This process encompasses all aspects of the sales, and is expected to streamline acquisitions in a cost effective and efficient manner.

With the signature of a Memorandum of Understanding (MOU) between Allied forces and the U.S. Navy's Directorate for Missiles and Surface Launchers (PEO TSC-M/L), a financial management process will be established to manage the sales of missiles to foreign governments. Part of this agreement includes the establishment of an International STANDARD Missile (SM) Project Office for the management of the cooperative program, which will include representatives from those participating nations. This project office must establish clear policies and procedures for the management of efforts and funding under the cooperative program. A team was established to develop a Financial Management Policies and Procedures (FMPP) document.

The FMPP document will be a living document and will cover production and R&D MOUs. The document provides policies and procedures to be followed including the process for amending the FMPP. Four appendices to the document include Project Financing Sequence of Events, Annual Production Financial Contributions, R&D Project Arrangement Contribution Plan, and Management of the Foreign Currency Contributions.

A data-sharing database, the Cooperative Projects Management Information System (CPMIS), was developed which can be easily updated/upgraded to keep up with technology, and has the capability of easily extracting data for manipulation in other programs. A competitive U.S. bank will be selected, and a signed agreement by the bank and the Program Office is being developed to effectively manage banking deposits and transfers for payment of services rendered by the contractors and field activities. Each country will appoint Cooperative Project Personnel (CPP) to manage the project under the MOU. The CCP will be responsible for banking transactions, milestone payments, deliverable tracking, reconciliation of accounts, and providing status reports to their respective country.

An annual process overview is conducted to negotiate a plan and execute any reconciliation issues. The effectiveness of this process remains to be seen, but all of the elements of a good process have been established. The process and associated procedures have been instituted to allow for changes in a smooth and efficient manner.

Obsolescence Management

The Directorate for Missiles and Surface Launchers began a formal Obsolescence Management program in 1997 in the absence of a formal methodology to support parts and material obsolescence.

The Directorate for Missiles and Surface Launchers (PEO TSC-M/L), like most program offices, was forced in recent years to begin recognizing and taking action to help resolve material obsolescence issues brought about by discontinued product lines and diminishing manufacturing sources. For PEO TSC-M/L, this issue began in 1997 in the absence of a formal methodology to support parts and material

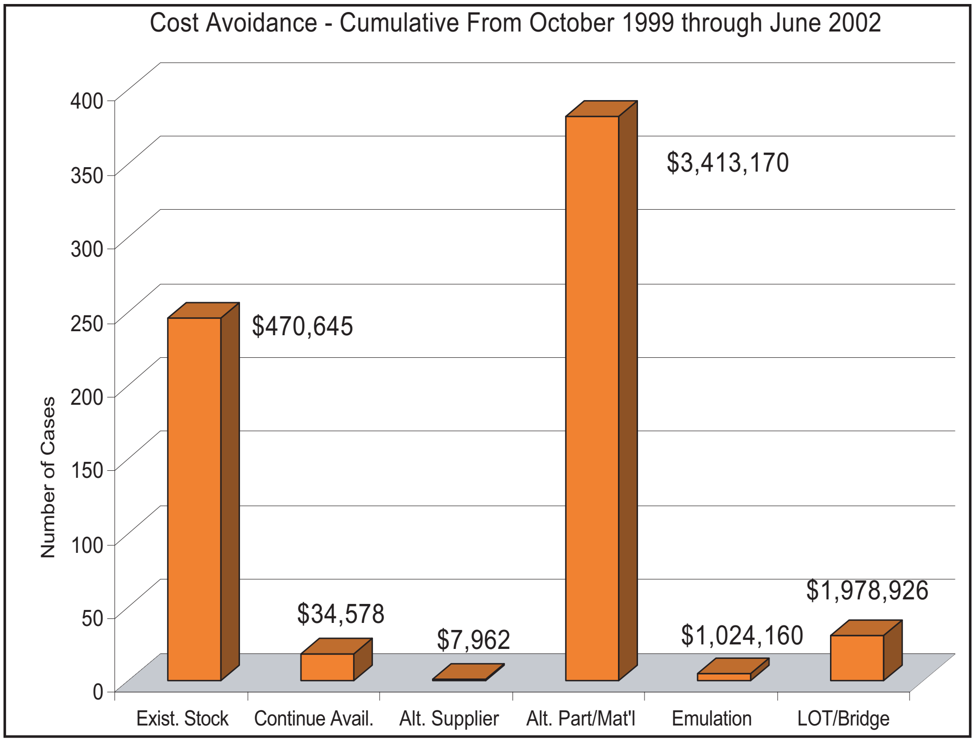


Figure 3-1. Obsolescence Management Benefits and Metrics

obsolescence. The Directorate appointed the prime contractor to take the leadership role, and an obsolescence management program was chartered. The prime contractor was responsible for heading the effort involving the vendors. Collaboration with other material groups was maximized to help monitor potential risk. A significant initiative was undertaken to optimize commonality of parts and materials across all prime contractor product lines during design and production. The main idea was to track obsolescence issues and their resolution. Proactive involvement across all missile variants was essential to success.

PEO TSC-M/L teamed with the contractor to develop several databases and models to facilitate the obsolescence management process. These tools depict the likelihood of obsolescence of all parts and materials, and they model costs associated with various solution options. One tool shows actual numbers of cases solved and the estimated cost avoidance associated with each (Figure 3-1) based on which solution type was implemented. For example, column one shows 245 cases were solved by using existing stock since October 1999, and the associated cost avoidance was $470,645. This represents money that was not spent because existing stock was found vs. having to move to the next, more expensive solution type—Continued Availability. The last, most expensive option after Life of Type/Bridge Buy is complete redesign. By using Life of Type/Bridge Buy vs. redesign, the cost avoidance was $1,978,926. The costs associated with each of these possible steps were obtained from the Defense Microelectronics Agency based on their historical information. These figures are being refined as the team collects actual data specific to STANDARD Missile (SM) and includes them in the cost model.

Appendix A
Table of Acronyms

ACRONYM	DEFINITION
ABMD	AEGIS Ballistic Missile Defense
APL	Applied Physics Laboratory
CAIV	Cost As An Independent Variable
CASREP	Casualty Report
CCB	Configuration Control Board
CDMS	Corporate Data Management System
CEWE	Collaborative Engineering Work Environment
CONUS	Continental United States
COTS	Commercial-Off-The-Shelf
CPMIS	Cooperative Projects Management Information System
CPP	Cooperative Project Personnel
DMSMS	Diminishing Manufacturing Sources and Material Shortages
EA	Item Engineering Agent
ECP	Engineering Change Proposal
ECR	Engineering Change Request
FMEA	Failure Mode and Effects Analysis
FMPP	Financial Management Policies and Procedures
FMS	Foreign Military Sales
FRACAS	Failure Reporting and Corrective Action System
FSMS	Future STANDARD Missile Strategy
IDMS	Integrated Data Management System
IPT	Integrated Process Team
ISEA	In-Service Engineering Agent
M&S	Modeling and Simulation
MCP	Mission Control Panel
MOU	Memorandum of Understanding
MRR	Mission Readiness Review
NAWC	Naval Air Warfare Center
NSWC	Naval Surface Warfare Center
NTW	Navy Theater Wide
PCTL	Program Critical Task List
PED	Plastic Encapsulated Device
PEM	Plastic Encapsulated Microcircuit
PEO TSC-M/L	Directorate for Missiles and Surface Launchers
PHD	Port Hueneme Division
POC	Point of Contact
RDA	Round Design Agent
RFP	Request for Proposal

SARP	Simulation Accreditation Review Panel
SEMP	Systems Engineering Master Plan
SM	STANDARD Missile
SM-2	STANDARD Missile-2
SM-3	STANDARD Missile-3
SMART	STANDARD Missile Assessment Reliability Team
SMP	Simulation Management Plan
TBMD	Theater Ballistic Missile Defense
TDA	Technical Design Agent
TechRep	Technical Representative
TI	Technical Instruction
TR	Trouble Report
TRIMS	Technical Risk Identification and Mitigation System
VECP	Value Engineering Change Proposal
VLS	Vertical Launch System
VV&A	Verification, Validation, and Accreditation
WBS	Work Breakdown Structure

Appendix B
BMP Survey Team

Team Member	Activity	Function
CDR Rick Schulz 703-805-5409	**Defense Acquisition University** Fort Belvoir, VA	**Team Chairman**
Caryl Bremer 301-403-8100	**BMP Center of Excellence** College Park, MD	**Technical Writer**
Breanne Avila 301-403-8100	**BMP Center of Excellence** College Park, MD	**Technical Writer**

Team A

Program Management/Logistics/Information Technology

Rose Thun 301-403-8100	**Computer Sciences Corporation** College Park, MD	**Team Leader**
Jill Garcia 703-805-3557	**Defense Acquisition University** Fort Belvoir, VA	
Bill Lieb 909-273-4969	**Naval Surface Warfare Center** Corona Division Corona, CA	

Team B

Engineering Design/Test/Manufacturing

Ron Cox 812-854-5330	**Naval Surface Warfare Center** Crane Division Crane, IN	**Team Leader**
Ken Lee 909-273-4998	**Naval Surface Warfare Center** Corona Division Corona, CA	
Chris Weller 202-482-8236/3975	**U.S. Department of Commerce** Bureau of Industry and Security Washington, DC	

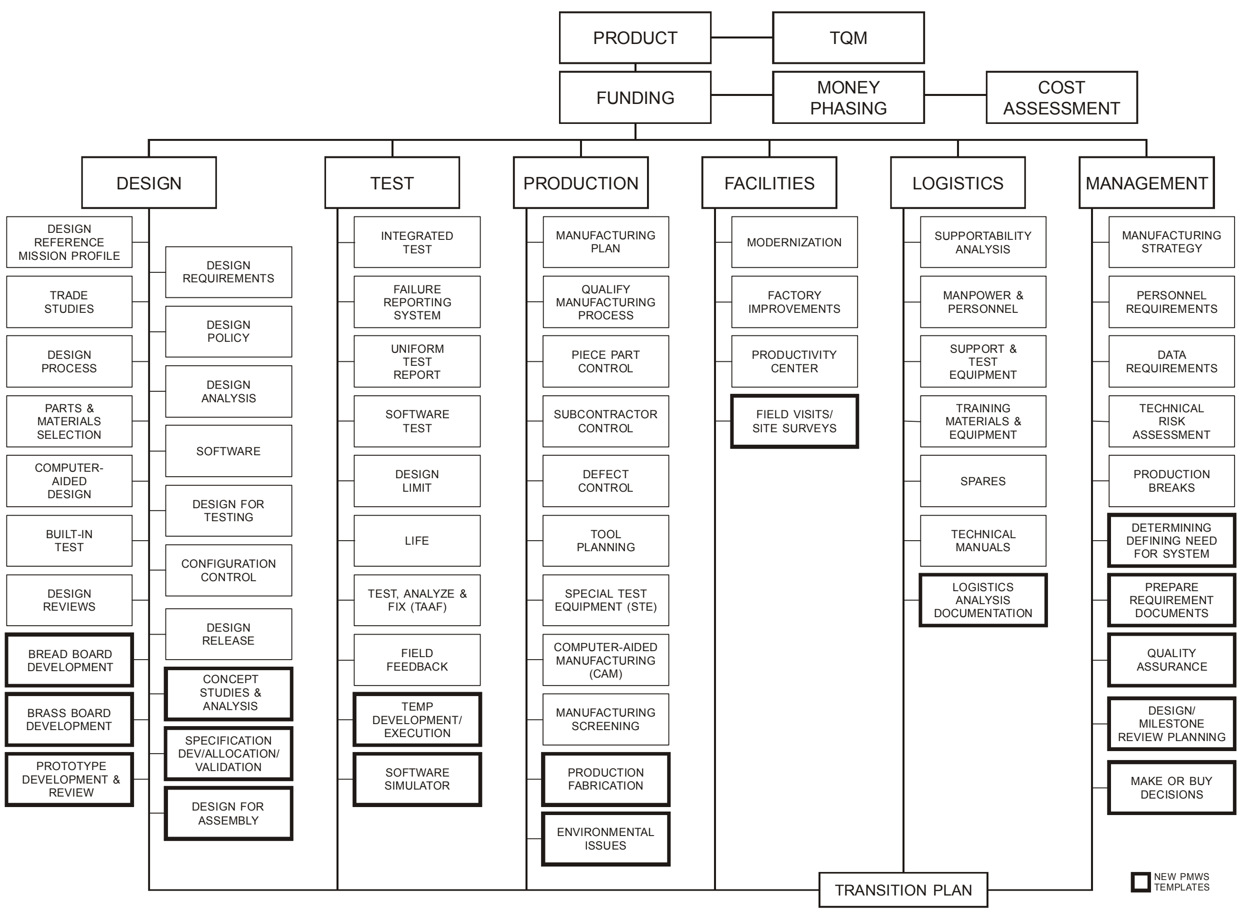
Appendix C

Critical Path Templates and BMP Templates

This survey was structured around and concentrated on the functional areas of design, test, production, facilities, logistics, and management as presented in the Department of Defense 4245.7-M, *Transition from Development to Production* document. This publication defines the proper tools—or templates—that constitute the critical path for a successful material acquisition program. It describes techniques for improving the acquisition process by addressing it as an *industrial* process that focuses on the product's design, test, and production phases which are interrelated and interdependent disciplines.

The BMP program has continued to build on this knowledge base by developing 17 new templates that complement the existing DOD 4245.7-M templates. These BMP templates address new or emerging technologies and processes.

"CRITICAL PATH TEMPLATES FOR TRANSITION FROM DEVELOPMENT TO PRODUCTION"



Appendix D

The Program Manager's WorkStation

The Program Manager's WorkStation (**PMWS**) is an electronic suite of tools designed to provide timely acquisition and engineering information to the user. The main components of PMWS are KnowHow; the Technical Risk Identification and Mitigation System (TRIMS); and the BMP Database. These tools complement one another and provide users with the *knowledge*, *insight*, and *experience* to make informed decisions through all phases of product development, production, and beyond.

KnowHow provides knowledge as an electronic library of technical reference handbooks, guidelines, and acquisition publications which covers a variety of engineering topics including the DOD 5000 series. The electronic collection consists of expert systems and simple digital books. In expert systems, KnowHow prompts the user to answer a series of questions to determine where the user is within a program's development. Recommendations are provided based on the book being used. In simple digital books, KnowHow leads the user through the process via an electronic table of contents to determine which books in the library will be the most helpful. The program also features a fuzzy logic text search capability so users can locate specific information by typing in keywords. KnowHow can reduce document search times by up to 95%.

TRIMS provides insight as a knowledge based tool that manages technical risk rather than cost and schedule. Cost and schedule overruns are downstream indicators of technical problems. Programs generally have had process problems long before the technical problem is identified. To avoid this progression, TRIMS operates as a process-oriented tool based on a solid Systems Engineering approach. Process analysis and monitoring provide the earliest possible indication of potential problems. Early identification provides the time necessary to apply corrective actions, thereby preventing problems and mitigating their impact. TRIMS is extremely user-friendly and tailorable. This tool identifies areas of risk; tracks program goals and responsibilities; and can generate a variety of reports to meet the user's needs.

The **BMP Database** provides experience as a unique, one-of-a-kind resource. This database contains more than 2,500 best practices that have been verified and documented by an independent team of experts during BMP surveys. BMP publishes its findings in survey reports and provides the user with basic background, process descriptions, metrics and lessons learned, and a Point of Contact for further information. The BMP Database features a searching capability so users can locate specific topics by typing in keywords. Users can either view the results on screen or print them as individual abstracts, a single report, or a series of reports. The database can also be downloaded, run on-line, or purchased on CD-ROM from the BMP Center of Excellence. The BMP Database continues to grow as new surveys are completed. Additionally, the database is reviewed every other year by a BMP core team of experts to ensure the information remains current.

For additional information on PMWS, please contact the Help Desk at (301) 403-8179, or visit the BMP web site at http://www.bmpcoe.org.

Appendix E
Best Manufacturing Practices Satellite Centers

There are currently ten Best Manufacturing Practices (BMP) satellite centers that provide representation for and awareness of the BMP Program to regional industry, government and academic institutions. The centers also promote the use of BMP with regional Manufacturing Technology Centers. Regional manufacturers can take advantage of the BMP satellite centers to help resolve problems, as the centers host informative, one-day regional workshops that focus on specific technical issues.

Center representatives also conduct BMP lectures at regional colleges and universities; maintain lists of experts who are potential survey team members; provide team member training; and train regional personnel in the use of BMP resources.

The ten BMP satellite centers include:

<u>**California**</u>

Chris Matzke
BMP Satellite Center Manager
Naval Surface Warfare Center, Corona Division
Code QA-21, P.O. Box 5000
Corona, CA 92878-5000
(909) 273-4992
FAX: (909) 273-4123
matzkecj@corona.navy.mil

<u>**District of Columbia**</u>

Chris Weller
BMP Satellite Center Manager
U.S. Department of Commerce
14th Street & Constitution Avenue, NW
Room 3876 BXA
Washington, DC 20230
(202) 482-8236/3795
FAX: (202) 482-5650
cweller@bis.doc.gov

<u>**Illinois**</u>

Thomas Clark
BMP Satellite Center Manager
Rock Valley College
3301 North Mulford Road
Rockford, IL 61114
(815) 921-3057
FAX: (815) 654-4459
adme3tc@rvc.cc.il.us

<u>**Iowa**</u>

Bruce Coney
BMP Satellite Center Manager
Iowa Procurement Outreach Center
2272 Howe Hall, Suite 2620
Ames, IA 50011
(515) 294-4461
FAX: (515) 294-4483
bconey@ciras.iastate.edu

<u>**Louisiana**</u>

Alley Butler
BMP Satellite Center Manager
Maritime Environmental Resources & Information Center
Gulf Coast Region Maritime Technology Center
University of New Orleans
UAMTCE, Room 163-Station 122
5100 River Road
New Orleans, LA 70094-2706
(504) 458-6339
FAX: (504) 437-3880
alley.butler@gcrmtc.org

<u>**Ohio**</u>

Larry Brown
BMP Satellite Center Manager
Edison Welding Instiitute
1250 Arthur E. Adams Drive
Columbus, Ohio 43221-3585
(614) 688-5080
FAX: (614) 688-5001
larry_brown@ewi.org

Pennsylvania

John W. Lloyd
BMP Satellite Center Manager
MANTEC, Inc.
P.O. Box 5046
York, PA 17405
(717) 843-5054
FAX: (717) 843-0087
lloydjw@mantec.org

South Carolina

Henry E. Watson
BMP Satellite Center Manager
South Carolina Research Authority - Applied
Research and Development Institute
100 Fluor Daniel
Clemson, SC 29634
(864) 656-6566
FAX: (843) 767-3367
watson@scra.org

Tennessee

Danny M. White
BMP Satellite Center Manager
Oak Ridge Center for Manufacturing and Materials Science
BWXT Y-12, L.L.C.
P.O. Box 2009
Oak Ridge, TN 37831-8091
(865) 574-0822
FAX: (865) 574-2000
whitedm1@y12.doe.gov

Virginia

William Motley
BMP Satellite Center Manager
DAU Program Director, Manufacturing Manager
Defense Acquisition University
9820 Belvoir Road, Suite G3
Ft. Belvoir, VA 22060-5565
(703) 805-3763
FAX: (703) 805-3721
bill.motley@dau.mil

Appendix F

Navy Manufacturing Technology Centers of Excellence

The Navy Manufacturing Technology Program has established Centers of Excellence (COEs) to provide focal points for the development and technology transfer of new manufacturing processes and equipment in a cooperative environment with industry, academia, and the Navy industrial facilities and laboratories. These consortium-structured COEs serve as corporate residences of expertise in particular technological areas. The following list provides a description and point of contact for each COE.

Best Manufacturing Practices Center of Excellence

The Best Manufacturing Practices Center of Excellence (BMPCOE) provides a national resource to identify and share best manufacturing and business practices being used throughout government, industry, and academia. The BMPCOE was established by the Office of Naval Research's BMP Program, the Department of Commerce, and the University of Maryland at College Park. By improving the use of existing technology, promoting the introduction of improved technologies, and providing non-competitive means to address common problems, the BMPCOE has become a significant factor to counter foreign competition.

Point of Contact:
Anne Marie T. SuPrise, Ph.D.
Best Manufacturing Practices Center of Excellence
4321 Hartwick Road
Suite 400
College Park, MD 20740
Phone: (301) 403-8100
FAX: (301) 403-8180
E-mail: annemari@bmpcoe.org

Institute for Manufacturing and Sustainment Technologies

The Institute for Manufacturing and Sustainment Technologies (iMAST) is located at the Pennsylvania State University's Applied Research Laboratory. iMAST's primary objective is to address challenges relative to Navy and Marine Corps weapon system platforms in the areas of mechanical drive transmission technologies, materials processing technologies, laser processing technologies, advanced composites technologies, and repair technologies.

Point of Contact:
Mr. Robert Cook
Institute for Manufacturing and Sustainment Technologies
APL Penn State
P.O. Box 30
State College, PA 16804-0030
Phone: (814) 863-3880
FAX: (814) 863-1183
E-mail: rbc5@psu.edu

SCRA Composites Manufacturing Technology Center

The Composites Manufacturing Technology Center (CMTC) is a Center of Excellence for the Navy's Composites Manufacturing Technology Program. The South Carolina Research Authority (SCRA) operates the CMTC and The Composites Consortium (TCC) serves as the technology resource. The TCC has strong, in-depth knowledge and experience in composites manufacturing technology. The SCRA/CMTC provides a national resource for the development and dissemination of composites manufacturing technology to defense contractors and subcontractors.

Point of Contact:
Mr. Henry Watson
SCRA Composites Manufacturing Technology Center
100 Fluor Daniel Engineering Building
Clemson, SC 29634-5726
Phone: (864) 656-6566
FAX: (864) 656-4435
E-mail: watson@scra.org

Electronics Manufacturing Productivity Facility

The Electronics Manufacturing Productivity Facility (EMPF) identifies, develops, and transfers innovative electronics manufacturing processes to domestic firms in support of the manufacture of affordable military systems. The EMPF operates as a consortium comprised of government, industry, and academic participants led by the American Competitiveness Institute under a Cooperative Agreement with the Navy.

Point of Contact:
Mr. Alan Criswell
Electronics Manufacturing Productivity Facility
One International Plaza, Suite 600
Philadelphia, PA 19113
Phone: (610) 362-1200
FAX: (610) 362-1294
E-mail: criswell@aci-corp.org

Electro-Optics Center

The Electro-Optics Center (EOC) is a national consortium of electro-optics industrial companies, universities, and government research centers that share their electro-optics expertise and capabilities through project teams focused on Navy requirements. Through its capability for national electronic communication and rapid reaction and response, the EOC can address issues of immediate concern to the Navy Systems Commands. The EOC is managed by the Pennsylvania State University's Applied Research Laboratory.

Point of Contact:
Dr. Karl Harris
Electro-Optics Center
West Hills Industrial Park
77 Glade Drive
Kittanning, PA 16201
Phone: (724) 545-9700
FAX: (724) 545-9797
E-mail: kharris@psu.edu

Navy Joining Center

The Navy Joining Center (NJC) provides a national resource for the development of materials joining expertise and the deployment of emerging manufacturing technologies to Navy contractors, subcontractors, and other activities. The NJC works with the Navy to determine and evaluate joining technology requirements and conduct technology development and deployment projects to address these issues. The NJC is operated by the Edison Welding Institute.

Point of Contact:
Mr. David P. Edmonds
Navy Joining Center
1250 Arthur E. Adams Drive
Columbus, OH 43221-3585
Phone: (614) 688-5096
FAX: (614) 688-5001
E-mail: dave_edmonds@ewi.org

National Center for Excellence in Metalworking Technology

The National Center for Excellence in Metalworking Technology (NCEMT) provides a national center for the development, dissemination, and implementation of advanced technologies for metalworking products and processes. Operated by the Concurrent Technologies Corporation, the NCEMT helps the Navy and defense contractors improve manufacturing productivity and part reliability through development, deployment, training, and education for advanced metalworking technologies.

Point of Contact:
Mr. Richard Henry
National Center for Excellence in Metalworking Technology
c/o Concurrent Technologies Corporation
100 CTC Drive
Johnstown, PA 15904-3374
Phone: (814) 269-2532
FAX: (814) 269-2501
E-mail: henry@ctc.com

Energetics Manufacturing Technology Center

The Energetics Manufacturing Technology Center (EMTC) addresses unique manufacturing processes and problems of the energetics industrial base to ensure the availability of affordable, quality, and safe energetics. The EMTC's focus is on technologies to reduce manufacturing costs, improve product quality and reliability, and develop environmentally benign manufacturing processes. The EMTC is located at the Indian Head Division of the Naval Surface Warfare Center.

Point of Contact:
Mr. John Brough
Energetics Manufacturing Technology Center
Indian Head Division
Naval Surface Warfare Center
100 Strauss Avenue
Building D326, Room 227
Indian Head, MD 20640-5035
Phone: (301) 744-4417
DSN: 354-4417
FAX: (301) 744-4187
E-mail: broughja@ih.navy.mil

Gulf Coast Region Maritime Technology Center

The Gulf Coast Region Maritime Technology Center (GCRMTC) fosters competition in shipbuilding technology through cooperation with the U.S. Navy, representatives of the maritime industries, and various academic and private research centers throughout the country. Located at the University of New Orleans, the GCRMTC focuses on improving design and production technologies for shipbuilding, reducing material costs, reducing total ownership costs, providing education and training, and improving environmental engineering and management.

Point of Contact:
Dr. John Crisp, P.E.
Gulf Coast Region Maritime Technology Center
University of New Orleans
College of Engineering
Room EN-212
New Orleans, LA 70148
Phone: (504) 280-3871
FAX: (504) 280-3898
E-mail: jcrisp@uno.edu

Appendix G

Completed Surveys

As of this publication, 129 surveys have been conducted and published by BMP at the companies listed below. Copies of older survey reports may be obtained through DTIC or by accessing the BMP web site. Requests for copies of recent survey reports or inquiries regarding BMP may be directed to:

Best Manufacturing Practices Program
4321 Hartwick Rd., Suite 400
College Park, MD 20740
Attn: Anne Marie T. SuPrise, Ph.D., Director
Telephone: 1-800-789-4267
FAX: (301) 403-8180
annemari@bmpcoe.org

1985	Litton Guidance & Control Systems Division - Woodland Hills, CA
1986	Honeywell, Incorporated Undersea Systems Division - Hopkins, MN (now Alliant TechSystems, Inc.) Texas Instruments Defense Systems & Electronics Group - Lewisville, TX General Dynamics Pomona Division - Pomona, CA Harris Corporation Government Support Systems Division - Syosset, NY IBM Corporation Federal Systems Division - Owego, NY Control Data Corporation Government Systems Division - Minneapolis, MN
1987	Hughes Aircraft Company Radar Systems Group - Los Angeles, CA ITT Avionics Division - Clifton, NJ Rockwell International Corporation Collins Defense Communications - Cedar Rapids, IA UNISYS Computer Systems Division - St. Paul, MN
1988	Motorola Government Electronics Group - Scottsdale, AZ General Dynamics Fort Worth Division - Fort Worth, TX Texas Instruments Defense Systems & Electronics Group - Dallas, TX Hughes Aircraft Company Missile Systems Group - Tucson, AZ Bell Helicopter Textron, Inc. - Fort Worth, TX Litton Data Systems Division - Van Nuys, CA GTE C^3 Systems Sector - Needham Heights, MA
1989	McDonnell-Douglas Corporation McDonnell Aircraft Company - St. Louis, MO Northrop Corporation Aircraft Division - Hawthorne, CA Litton Applied Technology Division - San Jose, CA Litton Amecom Division - College Park, MD Standard Industries - LaMirada, CA (now SI Manufacturing) Engineered Circuit Research, Incorporated - Milpitas, CA Teledyne Industries Incorporated Electronics Division - Newbury Park, CA Lockheed Aeronautical Systems Company - Marietta, GA Lockheed Missile Systems Division - Sunnyvale, CA (now Lockheed Martin Missiles and Space) Westinghouse Electronic Systems Group - Baltimore, MD (now Northrop Grumman Corporation) General Electric Naval & Drive Turbine Systems - Fitchburg, MA Rockwell Autonetics Electronics Systems - Anaheim, CA (now Boeing North American A&MSD) TRICOR Systems, Incorporated - Elgin, IL
1990	Hughes Aircraft Company Ground Systems Group - Fullerton, CA TRW Military Electronics and Avionics Division - San Diego, CA MechTronics of Arizona, Inc. - Phoenix, AZ Boeing Aerospace & Electronics - Corinth, TX Technology Matrix Consortium - Traverse City, MI Textron Lycoming - Stratford, CT

1991	*Resurvey of Litton Guidance & Control Systems Division* - Woodland Hills, CA Norden Systems, Inc. - Norwalk, CT (now Northrop Grumman Norden Systems) Naval Avionics Center - Indianapolis, IN United Electric Controls - Watertown, MA Kurt Manufacturing Co. - Minneapolis, MN MagneTek Defense Systems - Anaheim, CA (now Power Paragon, Inc.) Raytheon Missile Systems Division - Andover, MA AT&T Federal Systems Advanced Technologies and AT&T Bell Laboratories - Greensboro, NC and Whippany, NJ *Resurvey of Texas Instruments Defense Systems & Electronics Group* - Lewisville, TX
1992	Tandem Computers - Cupertino, CA Charleston Naval Shipyard - Charleston, SC Conax Florida Corporation - St. Petersburg, FL Texas Instruments Semiconductor Group Military Products - Midland, TX Hewlett-Packard Palo Alto Fabrication Center - Palo Alto, CA Watervliet U.S. Army Arsenal - Watervliet, NY Digital Equipment Company Enclosures Business - Westfield, MA and Maynard, MA Computing Devices International - Minneapolis, MN (now General Dynamics Information Systems) *(Resurvey of Control Data Corporation Government Systems Division)* Naval Aviation Depot Naval Air Station - Pensacola, FL
1993	NASA Marshall Space Flight Center - Huntsville, AL Naval Aviation Depot Naval Air Station - Jacksonville, FL Department of Energy Oak Ridge Facilities (Operated by Martin Marietta Energy Systems, Inc.) - Oak Ridge, TN McDonnell Douglas Aerospace - Huntington Beach, CA (now Boeing Space Systems) Crane Division Naval Surface Warfare Center - Crane, IN and Louisville, KY Philadelphia Naval Shipyard - Philadelphia, PA R. J. Reynolds Tobacco Company - Winston-Salem, NC Crystal Gateway Marriott Hotel - Arlington, VA Hamilton Standard Electronic Manufacturing Facility - Farmington, CT (now Hamilton Sundstrand) Alpha Industries, Inc. - Methuen, MA
1994	Harris Semiconductor - Palm Bay, FL (now Intersil Corporation) United Defense, L.P. Ground Systems Division - San Jose, CA Naval Undersea Warfare Center Division Keyport - Keyport, WA Mason & Hanger - Silas Mason Co., Inc. - Middletown, IA Kaiser Electronics - San Jose, CA U.S. Army Combat Systems Test Activity - Aberdeen, MD (now Aberdeen Test Center) Stafford County Public Schools - Stafford County, VA
1995	Sandia National Laboratories - Albuquerque, NM Rockwell Collins Avionics & Communications Division - Cedar Rapids, IA (now Rockwell Collins, Inc.) *(Resurvey of Rockwell International Corporation Collins Defense Communications)* Lockheed Martin Electronics & Missiles - Orlando, FL McDonnell Douglas Aerospace (St. Louis) - St. Louis, MO (now Boeing Aircraft and Missiles) *(Resurvey of McDonnell-Douglas Corporation McDonnell Aircraft Company)* Dayton Parts, Inc. - Harrisburg, PA Wainwright Industries - St. Peters, MO Lockheed Martin Tactical Aircraft Systems - Fort Worth, TX *(Resurvey of General Dynamics Fort Worth Division)* Lockheed Martin Government Electronic Systems - Moorestown, NJ Sacramento Manufacturing and Services Division - Sacramento, CA JLG Industries, Inc. - McConnellsburg, PA
1996	City of Chattanooga - Chattanooga, TN Mason & Hanger Corporation - Pantex Plant - Amarillo, TX Nascote Industries, Inc. - Nashville, IL Weirton Steel Corporation - Weirton, WV NASA Kennedy Space Center - Cape Canaveral, FL *Resurvey of Department of Energy, Oak Ridge Operations* - Oak Ridge, TN

1997	Headquarters, U.S. Army Industrial Operations Command - Rock Island, IL (now Operational Support Command) SAE International and Performance Review Institute - Warrendale, PA Polaroid Corporation - Waltham, MA Cincinnati Milacron, Inc. - Cincinnati, OH Lawrence Livermore National Laboratory - Livermore, CA Sharretts Plating Company, Inc. - Emigsville, PA Thermacore, Inc. - Lancaster, PA Rock Island Arsenal - Rock Island, IL Northrop Grumman Corporation - El Segundo, CA *(Resurvey of Northrop Corporation Aircraft Division)* Letterkenny Army Depot - Chambersburg, PA Elizabethtown College - Elizabethtown, PA Tooele Army Depot - Tooele, UT
1998	United Electric Controls - Watertown, MA Strite Industries Limited - Cambridge, Ontario, Canada Northrop Grumman Corporation - El Segundo, CA Corpus Christi Army Depot - Corpus Christi, TX Anniston Army Depot - Anniston, AL Naval Air Warfare Center, Lakehurst - Lakehurst, NJ Sierra Army Depot - Herlong, CA ITT Industries Aerospace/Communications Division - Fort Wayne, IN Raytheon Missile Systems Company - Tucson, AZ Naval Aviation Depot North Island - San Diego, CA *U.S.S. Carl Vinson* (CVN-70) - Commander Naval Air Force, U.S. Pacific Fleet Tobyhanna Army Depot - Tobyhanna, PA
1999	Wilton Armetale - Mount Joy, PA Applied Research Laboratory, Pennsylvania State University - State College, PA Electric Boat Corporation, Quonset Point Facility - North Kingstown, RI *Resurvey of NASA Marshall Space Flight Center* - Huntsville, AL Orenda Turbines, Division of Magellan Aerospace Corporation - Mississauga, Ontario, Canada
2000	Northrop Grumman, Defensive Systems Division - Rolling Meadows, IL Crane Army Ammunition Activity - Crane, IN Naval Sea Logistics Center, Detachment Portsmouth - Portsmouth, NH Stryker Howmedica Osteonics - Allendale, NJ
2001	The Tri-Cities Tennessee/Virginia Region - Johnson City, TN General Dynamics Armament Systems - Burlington, VT Lockheed Martin Naval Electronics & Surveillance Systems-Surface Systems - Moorestown, NJ Frontier Electronic Systems - Stillwater, OK
2002	U.S. Coast Guard, Maintenance and Logistics Command-Atlantic - Norfolk, VA U.S. Coast Guard, Maintenance and Logistics Command-Pacific - Alameda, CA Directorate for Missiles and Surface Launchers (PEO TSC-M/L) - Arlington, VA